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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 259.

B. T. GALLOWAY, *Chief of Bureau.*

WHAT IS FARM MANAGEMENT?

BY

W. J. SPILLMAN,

Agriculturist in Charge of the Office of Farm Management.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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BUREAU OF PLANT INDUSTRY.

Chief of Bureau, BEVERLY T. GALLOWAY.
Assistant Chief of Bureau, WILLIAM A. TAYLOR.
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Chief Clerk, JAMES E. JONES.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., May 29, 1912.

Sir: I have the honor to submit herewith a manuscript entitled "What is Farm Management?" and to recommend its publication as Bulletin No. 259 of the series of this bureau.

Farm management as a science and as a subject of investigation is new, and there is an insistent demand for information that will assist those who are engaged in teaching the subject, as well as those who are engaged in investigations relating to it.

This bulletin was prepared by Prof. W. J. Spillman, Agriculturist in Charge of the Office of Farm Management, and is in two parts. Part I is an outline of the science of farm management, which it is believed will be helpful to teachers in the agricultural colleges. Part II is an outline of the investigations conducted in the Office of Farm Management of this bureau. It discusses the principal problems under investigation and the investigational methods in use.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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WHAT IS FARM MANAGEMENT?

I.—THE SCIENCE OF FARM MANAGEMENT.

INTRODUCTION.

Farm management treats of the business of farming from the following standpoints:

(1) Relative desirability of farming and other lines of business.
(2) Selection of the farm.
(3) Organization and equipment of the farm.
(4) Farm operation.

In the brief consideration that can be given the subject here no attempt will be made to treat of these subdivisions exhaustively; nothing further will be attempted than to make clear the nature of the subject, to present an outline of it, and to point out some of the services it can be made to render to the farmer. In the literature of the subject certain parts of farm management have received more adequate treatment than others, and these are presented here in brief outline. Other parts of the subject are newer and have not received adequate treatment in the literature of the subject, for which reason they are treated at greater length in this bulletin.

FARMING AS AN OCCUPATION.

The relative desirability of farming as compared with other occupations is largely a personal matter and must be determined by the circumstances, tastes, and desires of the individual concerned.

Considered from the standpoint of stability, safety, and profitableness there are considerable differences between farming and other lines of business. It is for the most part made up of small independent units. Farming is, perhaps, more stable and less susceptible to serious interruption from disturbances in the financial world than any other business. On the other hand, it is perhaps more dependent on the elements than any other form of business. In addition, the average profits in farming are small.

Farming does not readily lend itself to corporation methods of conducting business and is therefore preeminently a business of individual rather than corporate enterprise. In fact, farmers as a class live so much to themselves and depend so little on each other in the conduct of their business that it is difficult to secure cooperation among them even when this cooperation would be highly advantageous to those concerned. Yet the hope of the future, that the farmer may be able to cope successfully with those who are in a sense organized against him or who are in position to take unfair advantage of him, lies in the possibility of developing cooperative effort, especially in the matter of buying and selling. This is more especially true in the case of selling perishable farm products, such as fruit and truck crops.

The numerous advantages and disadvantages of country life as compared with city life, which would be considered fully in a more extended treatise, can not be discussed in so brief an article as this must necessarily be.

SELECTION OF THE FARM.

The selection of the farm is of special interest to young men who look upon farming as their life work, to those seeking a new location, and to those who contemplate moving from the city to the farm. But even to the man who already owns a farm the considerations involved in selecting a farm are of value because they are helpful in aiding him to determine the value of his own property and to judge the adequacy of the improvements on it.

This subdivision treats of all those factors that affect the desirability of a region as a general location for farming as well as those which affect the value of particular farms. It deals with the climate, the character of the soil, the availability of farm lands, transportation facilities, the social and educational conditions, the general healthfulness of the region and of the particular locality, the character and availability of farm labor, and similar questions of general or regional significance. It also deals with individual farms from the standpoint of all those features that affect their desirability and value, such as the fertility of the soil, the topography of the land, the character of the improvements, the distance to market, the distance to schools and churches, the arrangement of the fields, the location of the buildings, etc.

These questions will not be discussed at length here, since the purpose of this bulletin is to define the subject of farm management rather than to discuss fully its details.

ORGANIZATION AND EQUIPMENT OF THE FARM.

The organization and equipment of the farm is the selecting of suitable enterprises as the basis of the farm business and of fitting them together into a satisfactory system of management. Ordinarily this means a system that will permit the maximum use of power, labor, and capital within the limits of the owner's available resources; that will require a minimum of equipment with the maximum use of that equipment; and that will so distribute the labor during the season that the farmer and his available labor, both of man and beast, will be profitably occupied at all times without being too much crowded at any one time. It also involves the determination of the character and extent of the equipment required for the satisfactory conduct of the business and the installation of this equipment.

SELECTION OF ENTERPRISES, OR CHOOSING THE TYPE OF FARMING.

By a farm enterprise is meant any crop, type of live stock, manufacturing process, etc., which constitutes a part of the farm business. One of the most responsible tasks the farmer is called upon to perform is the selection of the enterprises to be conducted on his farm. On the wisdom of his choice depends very largely the financial success of the business.

Enterprises are not always chosen because of their immediate profitableness; for instance, a crop may be grown for its effect on the soil or because of some special value as a feed, but, generally speaking, the leading consideration concerning any contemplated enterprise is the prospect of its being profitable under existing conditions. The principal factor to be considered in determining whether an enterprise would be profitable in any given case is the experience of farmers generally in the region. This, however, is not an absolute criterion, for one man may succeed where another would fail. It is therefore necessary to consider the general principles that apply to the case.

As a rule those enterprises that are of large extent, such as corn, wheat, hay, dairying, hog raising, and the like, are less subject to wide fluctuations in prices than those less extensive, such as truck farming, hop culture, bean growing, potato culture, etc. It is seldom wise to base the business of a farm entirely on enterprises that are subject to violent fluctuations in prices.

Hops will illustrate this point. This is a small enterprise, taking the country as a whole, and there is not room on the markets for more than a small fraction of the hops that could be produced if all the land suited to this crop were devoted to it. Yet when prices are

good the crop is highly profitable. These conditions result in eras of high prices followed by periods of overproduction and consequent low prices. In order to bring a satisfactory profit to the grower hops should sell for about 10 cents a pound. The price has been as high as $1 a pound at times, especially following a long period of low prices that caused many growers to destroy their hopyards. These high prices induce new planting, frequently great overproduction, and thus bring about a drop in prices. Hops have sold for $1 a pound one year and 4 cents a pound a year or two later, which, of course, brought ruin to the growers.

The lesson to be drawn from this is that when such an enterprise is adopted it should not be allowed to represent too large a proportion of the farm business, but should be only one of several enterprises.

The mere fact that an enterprise is small, taking the country as a whole, does not necessarily render it undesirable. Location with reference to markets has much to do in determining this point. There are many products that either because of their quickly perishable nature or because of their bulkiness and relative cheapness can not well be sent to distant markets, at least not without great expense. This is particularly true of market milk and some kinds of vegetables and fruits. Hence it follows that these enterprises are much more important in the agriculture of regions near the great market centers than elsewhere. But even where climate, soil, and distance to market render an enterprise feasible there may be market conditions that would make the enterprise unprofitable. Thus a farm may be well suited to the production of market milk, yet combinations of city dealers may fix prices in such a way as to leave the farmer little profit. Again, a farm may have soil well adapted to truck farming and be so near to market that transportation charges are unimportant, yet it is doubtful whether this type of farming is ever to be recommended to small farmers who can neither sell their produce direct to retail merchants nor take advantage of a farmers' marketing organization. Where the grower of truck crops must depend for his sales on an unknown commission merchant in a distant city, who has every opportunity to defraud the farmer, and the farmer's business is so small that he can not afford to go to the city to see that his shipments are honestly sold and paid for, truck farming is generally not profitable. Such considerations as these must not be overlooked in determining what enterprises to adopt in any given case.

It may sometimes happen that a crop is more or less eminently adapted to a particular soil type of very limited extent, or at least is vastly superior when grown on a particular soil of which the available area is relatively small. In such cases an enterprise which

is small in extent and hence is subject to rather violent fluctuations in production and prices may form a much larger proportion of the business of a farm than would ordinarily be wise.

A case in point is tobacco in certain sections where a superior quality of product is grown. If the soil of a farm is such as to enable the farmer to grow a product greatly superior to the usual grades on the market and the area of similar soil is not large enough to overstock the market even if all of it were devoted to this crop, then it follows that even if there is an era of overproduction in the crop most of the product must come from land not capable of producing the best quality. The crop will have to be abandoned on such land before it is abandoned on the better soils, which will leave the markets to those who have suitable soil for the crop. Not only that, but even during eras of low prices the lowest prices will not apply to the best quality of the product, so that even when prices are at their lowest there generally will be some profit for those who produce the best quality.

The relation of agricultural enterprises to climatic conditions is so obvious as to need only the merest mention here.

Another important consideration in deciding whether an enterprise is desirable under given conditions is the cost of the necessary equipment. Many farmers, especially of the tenant class, do not keep live stock because of the expense involved in securing the necessary breeding stock and the buildings required for sheltering them. Not infrequently a farmer will be found who could find a good market for a few acres, say, of potatoes or cabbages, but who is unable to avail himself of this opportunity because of the rather expensive machinery required to produce these crops economically. These are questions that must be taken into consideration in recommending types of farming.

Closely related to cost of equipment is the amount of labor an enterprise will entail, as well as the time of year when this labor must be done. In many cases the farmer is limited in the amount of labor he can command, and an otherwise desirable enterprise may be unsuited to the conditions because it would require too much labor or labor of a kind to which the farmer is not adapted. It frequently happens that a crop may be very desirable for many reasons and yet not be satisfactory in a given case because it demands attention at the same time as some more important crop. This is probably one of the reasons why the cowpea crop has made no more headway as a separate farm crop in this country. It demands work simultaneously with corn, the most important of all our crops, and in the South interferes with the work on both corn and cotton, the two most important crops of that section. The same thing is true of soy beans.

Both of these valuable legumes have had some difficulty in finding a place in American agriculture and apparently mainly because when they are introduced on the farm they tend to crowd out more important crops that demand labor at the same time.

Sometimes crops which may ordinarily be very profitable are found to be well adapted to a given locality and even to fit well in cropping systems that give a very satisfactory distribution of labor, and yet the limited market for the product may render it unwise to develop the enterprise to the fullest extent of its possibilities. The bean crop in the upper Columbia River basin is a case in point, or at least may be. The crop succeeds well in certain portions of this area, does not interfere with the labor on the wheat crop, which is the principal agricultural enterprise of the region, and occupies summer-fallow land that would otherwise lie entirely idle during the bean-growing season. Hence, if beans were one of the standard crops of the country, representing an enterprise so large that an increase of a few hundred thousand acres would have very little effect on the relative output of the crop, it would be permissible to develop the bean industry on a large scale in this region, which seems to be so well adapted to it. But the fact is that the bean crop is a small one, and any large increase in its acreage would result in a relatively large increase in the total crop. This would seriously affect prices. For this reason the development of the bean industry in the section in question must be made only after a careful study of the area adapted to the crop and the possibilities of a satisfactory market for the product should the output increase considerably.

Finally, the effect of an enterprise on the fertility of the soil is sometimes a determining factor in its adoption. Thus, thousands of farmers maintain herds of stock which do not return market prices for the feed given them, but they do this because of the effect the manure has upon the yield of their crops. In very many cases this practice is justifiable. Suppose a farmer with no live stock except work animals could produce 35 bushels of corn per acre, while with a full complement of stock on his farm he could produce 80 bushels. Suppose he could sell his corn for 60 cents a bushel and that he can get 40 cents a bushel by feeding it; which practice, in the long run, is the most profitable? Thirty-five bushels at 60 cents is $21 per acre; 80 bushels at 40 cents is $32 per acre. Hence, under the conditions assumed, the keeping of live stock would bring $11 per acre more income than the system of selling corn on the market. This $11, however, is not all profit, for the interest on the investment in live stock and the labor cost of keeping the stock must come out of it.

Again, leguminous crops are very frequently grown because of their beneficial effect on the soil, even when some other crop might be temporarily more profitable. Thus, clover is regularly grown on hundreds of thousands of farms without direct profit but with much benefit to the land. Usually, however, the clover crop is directly profitable, but seldom so much so as corn, for instance. In a few localities the production of clover seed is quite profitable. In the South cowpeas are grown extensively as a catch crop in corn, simply for the effect on the soil. Alfalfa, the great leguminous crop of the West, is not only highly beneficial to the soil, but is frequently one of the most profitable crops the farmer can grow. It is, therefore, not surprising that in sections where this crop succeeds well it usually occupies a commanding place on the farm, much more so than clover does in its territory and vastly more so than do cowpeas in the South.

The factors which must be taken into consideration in determining the desirability of an enterprise in any given case may be summarized as follows:

(1) Profitableness, as determined by general and by local experience.
(2) The extent and distribution of the enterprise. This has much to do with the stability of the supply and demand.
(3) Location with reference to markets.
(4) Conditions existing in the market centers, especially combinations of dealers which control prices.
(5) Soil and climatic conditions.
(6) Cost of equipment required.
(7) Amount and character of labor required.
(8) Seasonal distribution of labor.
(9) Extent of a possible market for the product and the probable effect of a considerable increase in the supply on market prices.
(10) Effect of the enterprise on the fertility of the soil.

In an extended treatise on farm management each of the principal agricultural enterprises would be considered in detail from the standpoint of each of the foregoing factors.

TECHNOLOGICAL PROCESSES ON THE FARM.

A full discussion of farm organization would involve the discussion of the use of technological processes on the farm, both as a means of filling in gaps in the labor schedule and as a means of securing enhanced prices for the products of the farm. The nature of these processes will necessarily vary with climatic conditions, as well as with the type of raw materials which may be produced on the farm or may be easily procurable for such processes. Some of the leading ones conducted on American farms and therefore worthy of consideration in this connection are the curing of meats, the

making of butter and cheese, and sirup making. In a treatise on farm management these processes would not be considered from the standpoint of methods of conducting them, but from the standpoint of their desirability under different conditions, the equipment and labor they require, the cost of equipment, and the financial results to be expected from them.

LABOR REQUIREMENTS OF ENTERPRISES.

The farm-management view of a crop is quite different from the agronomic view. The agronomist, or crop specialist, considers a crop from the standpoint of its requirements as a living, growing thing. It is his work to learn what effect different methods of treatment will have on yield; in short, to learn how to manage the crop to produce the largest yield. He considers the rate of seeding, the depth of planting, methods of preparing the seed bed, fertilizer requirements, methods of tillage, methods of harvesting, and the like.

In studying farm organization, which is one of the leading phases of the subject of farm management, our interest in the crop relates to the amount and kinds of labor required in the management of the crop and the equipment necessary in performing that labor. In order to formulate a cropping system that will give an equitable distribution of labor during the season, we must know the following facts concerning each crop to be used in the system:

(1) The kind and number of operations required by the crop from the beginning of the seed-bed preparation to the marketing of the product.

(2) The crews (men, horses, and machinery) that may or should be used in performing these operations.

(3) The dates between which each operation may or must be performed.

(4) The amount of work each crew should perform in a day. This involves standards of farm labor for all possible kinds of farm work.

(5) The proportion of time at all seasons of the year that can be devoted to the kind of work to be done. This requires a knowledge of the average amount of time lost because of unfavorable weather, holidays, unavoidable delays, etc.

These five classes of data concerning a farm enterprise constitute the fundamental farm-management data concerning that enterprise. Until they are made available it will be impossible to work out, except by the slow and costly methods of experience, systems of farming that will give a satisfactory distribution of labor and which will give the farmer something profitable to do at all seasons of the year, while at the same time no part of the year will be so crowded with labor as to make it difficult to get the work done in its proper season. With such data it will be possible to formulate systems that will not only distribute the labor advantageously but will greatly reduce the number of work animals necessary to farm a given area. The aver-

age farm horse in the Northern States works on the average for the year only about three hours a day. Yet at certain seasons of the year he not only works 10 or 12 hours, but the farmer seldom has enough horses to do the required work. With a properly planned cropping system it will be possible to so distribute the horse labor as to secure twice the above amount of work per horse, thus reducing by one-half the number of horses required to farm a given area.

By distributing the work in this manner it will become possible to prevent a great deal of duplication in farm implements as well. Thus, on a farm where the system of management requires the plowing of the whole farm in the spring, only a few acres can be plowed with one plow, and there must be plows as well as horses and men enough to plow the whole farm in a short time. But if the work is so distributed that about half the land can be plowed in the fall, then one plow can be used on twice as many acres in a season as under the other system. This will reduce the number of plows required.

Thus the purely farm-management data concerning the management of a crop relate to the work the crop requires and to the relation this work bears to the work required by the other enterprises conducted on the farm, or which may be introduced to advantage. Agronomy is concerned with how to treat the crop in order to get it to thrive best; farm management is concerned with how to get the work done which the agronomist says should be done.

CRITICAL PERIODS OF ENTERPRISES.

Most farm enterprises require more work at some seasons of the year than at others. The cotton crop, for instance, has two periods at which it demands an unusual amount of work—i. e., chopping out (thinning) and picking. A man can prepare the land, plant, and cultivate a much larger area than he can chop out or pick. It is customary in the cotton States for all the members of the grower's family who can handle a hoe or pick cotton, both light tasks suitable to women and children, to aid at these critical periods. Even with this help one man can still do all the other work on a much larger crop than an ordinary farm family can care for during the critical periods. It is clear that the limiting factor in the area of cotton a farmer can manage properly is the area he and his available labor can thin and pick. Where the available labor is limited to the members of the farmer's family, this area is so small in the case of the average family that a single horse can do all the horse labor required on the farm. This accounts for the general prevalence of 1-horse farming in the South. So long as southern agriculture is based as largely on cotton as it has usually been during the last generation, the 1-horse farm will be an economic necessity.

There is a better way, however, even for the cotton country. By the proper selection of enterprises the cotton grower may produce a large acreage of other crops, especially if he utilizes two horses, without cutting down the acreage of his cotton crop. But to do this it will be necessary to select enterprises that will not require much attention, if any, during cotton chopping or picking time. One of the big farm-management problems of the South is the formulation of systems of farming that will utilize the forces that now go to waste at seasons when the cotton crop does not completely employ the farmer's time and equipment.

The critical periods for the potato crop are planting and harvest. Corn is a crop that has no strictly critical period. It gives about the same amount of work at all times, from the beginning of plowing the seed bed to the last cultivation. Even at harvest time one man can gather all the corn he can grow, though it is customary to employ extra labor at this time. Generally speaking, farm enterprises have one or more periods when so much work is required that those periods determine the extent of the enterprise in any given case.

SEASONAL DISTRIBUTION OF LABOR.

Farm-management surveys conducted by Cornell University and by the Office of Farm Management have shown that, within limits, the labor income of the farmer increases with the size of his farm, and, especially on small farms, with the diversity of the enterprises followed; that is, large farms are more profitable than small ones, and farms having several kinds of products to sell are more profitable than farms having only a few kinds to sell. The reason for both of these facts is probably the same, i. e., that a large farm even when devoted to a few of the leading farm enterprises and a small farm having a large number of enterprises will ordinarily give the farmer opportunity to find profitable employment for a greater portion of the year than a small farm with only a few enterprises. In both cases, also, the farmer has the opportunity to employ more labor, both of man and beast, as well as more capital.

One of the faults of American agriculture is the lack of systems of management that will keep the farmer properly busy at all times during the year. On cotton farms in the South there are, as we have already seen, just two really busy seasons, i. e., chopping time and picking time. The area of cotton that an ordinary farm family can thin in the spring and pick in the fall is so small that it does not keep one man well occupied the rest of the year.

In many sections corn and oats are the principal crops grown. Both of these crops cause much work in the early spring, and corn gives work until time for the oat harvest early in July. But after

the oats are harvested there is a period of a month or two when there is no field work to do. Examples of this kind could be multiplied indefinitely.

In almost no section of the country do the systems of farming employed furnish the farmer profitable employment during the winter. It is possible, by proper choice of enterprises and by properly gauging the magnitude of each enterprise, to organize the work of a farm in such a manner as to give profitable employment to the farmer and his available labor throughout at least the greater part of the year, certainly during the entire season when field work is feasible. Some such systems are given later in this bulletin.

While in most cases it is desirable to have systems of management designed to give profitable employment at all seasons, there are conditions under which the farmer is justified in ignoring this point. For instance, it may be possible to devote the major portion of the farm to some crop that is very much more profitable than any other crop that could be grown. In such cases, if the farmer can get all the labor he wants when he wants it, and is not compelled to support this labor when he has no use for it, a condition which is, of course, exceptional, he may be justified in growing as much of that crop as the exigencies of good soil management will allow.[1]

In some cases farmers are so situated that they can find profitable employment for their available labor in clearing land, quarrying stone, cutting and hauling cordwood or staves, etc., when they are not needed on the farm. Such men are fortunate, for in their cases one of the most difficult problems, that of formulating a system that will give profitable employment the year round, is solved in advance. But such cases are exceptional. Nearly all farmers are compelled to find employment on their own farms and on enterprises connected with the leading crops and types of live stock of the country. Since these standard enterprises tend to remain approximately equal so far as their profitableness is concerned, it follows that the larger the proportion of the year for which the system provides work the greater is the labor income.

CROPPING SYSTEMS.

It is impossible here, for lack of space, to consider all the various cropping systems in vogue in different parts of the country, or even the principal ones of the leading agricultural sections, to say nothing of outlining systems that give full utilization of the farmer's time and equipment. A few systems will be considered merely for the purpose of illustration. We shall find in their relation to the dis-

[1] See the article entitled "Seasonal Distribution of Labor on the Farm" in the Yearbook of the Department of Agriculture for 1911 for further discussion of this point.

tribution of labor and the utilization of power an explanation of some of the more prominent anomalies of American agriculture.

We have already seen that the limiting factor in the area of cotton an average farmer can grow is the quantity the members of his family can pick. This is about seven bales. On ordinary uplands, where the yield is about one-third of a bale per acre, this means about 20 acres of cotton to the family. One horse can till this acreage, and as no other money crop is grown a farm of this size is usually a 1-horse farm. A few acres of corn are grown, but as there is only one horse and as the cotton tillage keeps him quite busy, the corn is poorly tilled and yields very little. Because the implements used are all 1-horse implements, the preparation of the seed bed for cotton, the planting, and the tilling keep the farmer busy from early in the spring until late in July. The picking then occupies the fall season quite completely. Thus, the one crop gives the farmer employment during nearly the entire season. This is one of the reasons that the single-crop system of cotton growing has persisted so tenaciously in the South; it gives employment pretty nearly as constantly as a well-planned system of farming would do, and thus enables the farmer to earn a living. The difficulty is that it does not utilize the full possibilities of the man and therefore gives him a poor living. When a man is following a 6-inch plow or a 12-inch sweep drawn by an 800-pound mule his time may be fully but not well utilized, and he is not working at his full earning capacity. What the cotton growers of the South need are systems of farming that will permit one man to employ the full power of two or, better, four horses throughout the season. This would greatly increase the earning capacity of the individual.

If the good farm lands now unused, mostly in second-growth timber, were devoted to such cropping systems the South could with its present working force grow approximately its present acreage of cotton and at the same time devote twice or three times this area to other crops. This would, of course, require a large increase in the number of work animals used as well as in implements, and this would call for much more capital than is now available to the farmers of that section. When the problems here briefly discussed have been worked out for the South and southern agriculture begins rapid expansion to its full possibilities, there will be great need of sources of agricultural credit so that the money may be had for that development.

In the Pacific Northwest there exists a peculiar system of agriculture which illustrates some of the principles here discussed. In certain sections the farmers grow little else than wheat. Unlike cotton, this crop has no critical period during which it requires a vast

amount of hand labor, but can be handled from start to finish almost entirely by horse or mechanical power.

In eastern Washington the limit to the area of this crop one man can grow is the acreage of land he can prepare for seeding. In the preparation of the land one man can easily utilize five or six horses, and we actually find this number commonly used by one man. All the implements are made as large as practicable. By a further ingenious device the season for preparing the land is lengthened. A given field bears a crop only once in two years. The farmer therefore has a long time in which to prepare the land. But this time is not as long as might be expected, because the winters in that section are too wet to permit much field work and the summers are so dry that the soil soon becomes too hard to plow. But by double disking the land very early in the spring, which can be done before it is dry enough to plow, a mulch is created which keeps the soil mellow till late in June. Thus, with 5-horse teams and a comparatively long season in which to do the plowing, a large area can be prepared by one man. In fact, the typical size for a one-man exclusive wheat farm in that section is about 320 acres, on which 160 acres of wheat are grown annually. Managed in this way, a wheat farm gives the farmer plenty of profitable work to do from early in the spring until nearly harvest time. Then the harvest season gives another long period of work. In that region the varieties of wheat grown will stand several weeks after they are ready to cut, so that the harvest season is greatly prolonged, and with the system of harvesting in vogue there is no trouble about getting all the wheat cut and thrashed that a farmer can grow. When harvest is over it is about time to begin sowing a new crop on the land that was plowed in the spring.

Thus, the system followed not only enables a man to utilize much power but it gives work through a considerable portion of the season. Under normal conditions this system of farming is quite profitable, and many farmers have grown quite wealthy in the wheat business. But there are dangers in the system, as the farmers very well know. Once for a period of three years the price of wheat was so low as to cause heavy losses. It is also probable that another generation of this type of farming would result in soil depletion to such an extent as to be disastrous.

This system does not use all the time and power one man could employ, and it leaves half the land idle every year. Methods of obviating these difficulties are now being worked out for certain localities, but it would require too much space to detail these here. Enough has been said to show why the farmers have clung so tenaciously to this system of farming in the face of urgent persua-

sion on the part of those who saw the defects but not the excellencies of the system.

The essential difference from an economic point of view between the prevailing methods of growing cotton in the South and wheat in the Palouse country is in the amount of horsepower one man can use in the two cases. The fact that machinery is not yet used for the most critical period of the cotton crop—the picking—and that the area of this crop a family can grow is therefore limited to what they can pick, and that this area is very small, renders it impossible on an exclusive cotton farm to profit by the possibility of using more power in plowing and in cultivation.

On the other hand, what was formerly the critical period for the wheat crop—the harvest—when this had to be performed by hand, is now not a limiting factor, for the farmer can get wheat harvested and thrashed from all the land he can plow, harrow, and sow. The real limit to the area of wheat one man can grow is the area he can plow in season. In this work he can readily use the power of five horses. For this reason he is able to farm a much larger area and secure a much larger income than the cotton grower.

The only way the cotton grower can get into the class of the wheat grower from the standpoint of income is by hiring a large amount of human labor at low wages for the two hand operations the cotton crop requires. As a result of this condition, most of the cotton is grown under a tenant system by poor people, while wheat is grown by the owner of the land himself, who is usually a well-to-do farmer. This applies, of course, only to those localities where the methods outlined are practiced.

A financial comparison of the two one-man systems of farming is shown in Table I.

TABLE I.—*Comparison of two one-man systems of single-crop farming.*

Crop.	Charges.			Income.	
	Rent.	Interest and depreciation on equipment.	Total.	Gross.[1]	Labor.[1]
Cotton	[2] $72	$15	$87	[3] $350	$263
Wheat	[4] 1,152	165	1,317	[5] 2,880	1,563

[1] The farm expenses other than rent, depreciation, and interest on crop equipment are not here taken into account. Hence the labor income given is not the net income.

[2] Twenty acres at $3.60.

[3] Seven bales from 20 acres.

[4] Three hundred and twenty acres at $3.60.

[5] Four thousand eight hundred bushels (from 160 acres) at 60 cents.

Thus the possibility of using more power in the one case not only gives a much greater labor income, but the possibility of using more capital gives a correspondingly greater interest income.

Until the problems of thinning and picking cotton by machinery are solved the one-man farm must continue to bring only a bare living to the man who grows the cotton, provided he grows little else.

There are two alternatives for the cotton grower. In order to use more capital and more power and thus increase his income, he must either employ a great deal of cheap human labor or change to a system of farming that will permit him to use more power for those operations on the cotton crop which permit it, such as plowing and cultivating, and devote the time thus saved to other enterprises which also permit the use of a maximum of power. It is the province of the newly developing science of farm management to work out such systems for the cotton country.

While the two systems of farming just described are distinctly faulty and have been condemned by the best authorities, the fact is that, considered from the standpoint of labor distribution and the full utilization of a man's abilities, they are not much worse than the systems that prevail quite generally over the country. In fact, the system of wheat growing outlined utilizes a man's possibilities to far better advantage, and so long as the soil holds out and the price of wheat is satisfactory is far more profitable to the farmer than the systems prevailing in most parts of the country.

In general, even in the case of single-crop systems like those described, and more especially in the case of the more complex systems prevailing in the corn belt, the systems of farming that have been worked out by the cut-and-try method of experience will be found to give a first approximation to good seasonal distribution of labor and full utilization of equipment. This is necessarily so, for if it were not the case the farmers would long ago have been forced out of business.

The systems that have survived represent a sort of natural selection in which those that furnished the farmer a living survived, while the others disappeared. It is not exactly the survival of the fittest; it has been rather the elimination of the utterly unfit. Especially does the rotation of corn, wheat, and hay approach an ideal distribution of labor and use of equipment when the area of the farm happens to be just right and when the rotation is properly arranged. Thus a 6-year rotation of corn, corn, wheat,[1] wheat,[1] timothy and clover, timothy and clover gives a distribution of horse labor that is almost absolutely uniform from early in the spring until late in the fall. This keeps every needed horse busy and obviates the necessity of hiring extra horses as well. This system calls for extra man labor at wheat harvest, hay harvest, and in the corn harvest, but at other times the amount of man labor needed is just the same at all times.

[1] Fall sown. This rotation is adapted only to middle latitudes.

The area one man can farm with such a system is limited by the following factors:

(1) The area of corn land he can prepare for planting.
(2) The area of corn he can till.
(3) The area of wheat land he can prepare in the fall.

Fortunately, these three factors are equal. With two good horses one man can handle 40 acres of each of these projects. Hence, with this system he can farm 120 acres of arable land without extra labor except at harvest time. With four good horses it would seem that one man ought to farm 240 acres in this rotation, though this has never been even approximated in practice, so far as the writer knows. One farmer has been found who is actually farming the 120 acres that theoretically he should be able to farm with two horses.

The type of rotation found most generally on farms in the region to which this rotation is adapted is a first approximation to this one, which gives an ideal distribution of labor and reduces equipment to a minimum. These rotations are practically always some form of the general one of corn, small grain, timothy and clover. But since the farmers generally have not the data to work out the labor distribution of a system accurately—indeed, no one has this information sufficiently exact—the actual systems in vogue are only rough approximations of what they ought to be.

Another system of rotation that gives an even distribution of horse labor, so that a minimum number of horses can do the work of the farm, and that requires extra man labor only at harvest time, while at other times the regular help is kept reasonably busy at remunerative employment, is corn, corn, cowpeas (or soy beans) sown broadcast, wheat, wheat. With two good horses one man can manage 75 acres in this rotation; with four horses he should manage 150 acres. Reference is here made only to the field work. This last rotation would furnish cowpea hay, straw, and corn stover, all of which could be used to advantage as feed for live stock, especially dairy cows. A good herd of cows furnishes labor equally distributed throughout the year, so that a dairy farm with the rotation mentioned would represent an excellent system from the standpoint of the distribution of labor and economy in equipment.

Generally speaking, any cropping system which has stood the test of time and prevails pretty generally over an important agricultural region will be found to give at least an approximation to uniform distribution of labor with minimum equipment. But when the farmers in a region where rather poor farming is done attempt to break away from prevailing practice and begin to invent new rotations, under the impression that rotation farming is an improve-

ment over the prevailing methods in their locality, the crude rotations often resulting are frequently very far from satisfactory from the standpoint of equipment and labor distribution. It not infrequently occurs in such cases that the new system necessitates the plowing of all the land on the farm in the early spring. To do this requires an army of horses and plows as well as plowmen. The plowmen can be hired temporarily, but as a rule the farmer must own the plows and horses. He must also be supplied with harrows, cultivators, etc., to correspond. After the rush of spring work is over nearly all of the horses and equipment stand idle for most of the season. Such systems do not last long and never become general in a region.

Enough has been said here to show that the work of reorganizing the agriculture of a region that for any reason is in an unsatisfactory condition is a task worthy of the best minds in the country. The farmers, unaided by the scientific investigation of the subject, will finally reach an approximate solution of the problem, but the process will be so slow that by the time this approximation is reached changed economic conditions may have rendered the new systems worked out by the farmers unsuited to the then existing conditions. Hence this is the work of the agricultural scientist, and the investigator is confronted by no more important or difficult task than that of farm reorganization. It is practically a virgin field. The fundamental data on which such work must be based are not yet at hand. The present task of the farm-management investigator is to secure these data.

THE AREA ONE MAN CAN FARM.

Of the factors that determine the size of the one-man farm the most important is the enterprises adopted, and, as we have just seen, it is the critical periods of these enterprises that are important in this respect. But the extent of a single enterprise that one man can manage depends on a number of factors, the most important being the character of equipment used.

In most sections of the country it is customary to employ temporary labor during critical periods, especially at harvest time. With cropping systems that require only extra man labor at critical periods and no extra horse labor, and where it is possible to arrange such systems, it is usually quite feasible to increase the acreage farmed to the largest area that the available horse labor will provide for, since it is usually possible to secure extra man labor, even when extra horse labor can not be had. Where extra man labor can be had at harvest time, then the area farmed will depend on the number of horses one man can utilize. In many cases it is practical to do almost all the field work with 4-horse teams. To do so, of course, doubles the area one man using a 2-horse team can farm.

The length of the season during which field work can be done also influences the area a given force can farm. In sections where the field work can begin in the very early spring, as it can all over the South, one team can prepare more land for seeding than in sections where the spring season is short, as it is in the northern tier of States. On the other hand, the heat during summer in the Southern States tends to reduce the acreage that can be tilled by a team.

The character of the soil also affects the area a team can plow and till. On light sandy soils a team can cover more ground at most operations than on heavy clay soils. The presence of stones, as in many New England fields, and the presence of roots and stumps, as in newly cleared land, also reduce the area that can be farmed. On irrigated land the area a given force can farm is smaller than on non-irrigated, for the irrigating takes time, and the presence of ditches in the fields, causing frequent turning on short rows, reduces the area that can be covered in a day.

Uniformity of equipment is another factor often overlooked. On a 4-horse farm it is a waste of time to have part of the field implements of a size adapted to two horses and another part to three. By using only 4-horse implements in so far as this is practicable the time of one man is frequently saved, or if only one man is available the constant use of 4-horse implements greatly increases his efficiency. One of the problems to be worked out by farm-management investigators is the practicability of using implements of uniform size for field work, especially the sizes that utilize the largest possible amount of power, or at least all the available power on the farm.

RELATION OF MAGNITUDE OF BUSINESS TO PROFIT.

Profit in farming depends not only on the intrinsic profitableness of the enterprises adopted, but also to a great extent on the amount of power employed and the amount of capital invested. If there is profit in an enterprise conducted on a small scale, there ought to be more profit in it when conducted on a larger scale. A system of farming that limits the farmer to the use of one horse gives less opportunity for a large income than one that permits one man to use four or five horses to advantage. A comparison has already been given of two types of farming which illustrate this. Any system of farming that limits the worker largely to what he can do with his hands, without the aid of horse or mechanical power of some kind, will, as a rule, bring small returns, and those who follow it will have incomes little, if any, larger than ordinary wages. At least in the case of crop products grown for sale the amount of horsepower the grower can utilize to advantage is an index to the labor income a man can make single handed—i. e., on a one-man farm.

In order to secure the larger use of power and capital either of two methods may be pursued. In localities near the large market centers and on some farms near smaller centers the more intensive types of farming may be instituted, in which the amount of work to be done on a given area is large and in which much capital may be advantageously employed. In localities where such intensive enterprises are not appropriate because of lack of a suitable market for the products the best means for the farmer to employ to put himself in a position to use more capital and employ more power is to increase the size of his holdings either by purchase or by renting. Some of the most prosperous farmers in the country are farming rented land. These are men whose capital is too small to permit them to own large tracts of land, and they wisely lease as large an area as their capital will permit them to equip and farm properly, thereby securing the possibility of using much power with comparatively little capital.

The size of the farm should, if possible, be large enough to permit the farmer to use as much power as his capital renders possible, whatever the type of farming adopted.

THE NORMAL SIZE OF FARMS.

In those sections of country where the farmers must in the main depend on the ordinary field crops and the common types of live stock the normal size of the farms may be assumed to be such as to give full employment to the number of horses worked in one team to the best advantage. As 2-horse teams are much more commonly used than any other in most parts of the corn belt, it would naturally be expected that the 2-horse farm, or rather the farm that would keep one 2-horse team busy with the field work, would be the most practicable size for which to formulate a satisfactory working plan. It must be remembered that the average farm is not very well planned, and that for this reason one team does not ordinarily do the field work for areas as large as those above shown to be possible with a well-planned system.

In this connection the statistics concerning the relative numbers of farms of different sizes as given in recent data of the Bureau of the Census are of great interest. We should expect to find that those sizes of farms would be most frequent that permit fairly good organization with the least difficulty. This means, in the corn belt, the 2-horse farm. Farms smaller than the full capacity of two horses would not give full employment of labor and equipment when ordinary field crops are grown, and in the corn belt generally these are the leading enterprises of the average farm. Hence, these smaller farms would not be so profitable, or rather it would be more difficult

to make them profitable, and the number of the smaller farms would tend to decrease while the farms of a size adapted to easy organization along economic lines would increase in number. The facts as to this point are given in Table II for some of the leading corn-belt States.

TABLE II.—*Change in sizes of farms in the corn belt.*

[Sizes which are increasing in number are marked plus (+), those decreasing in number are marked minus (−), and those stationary are marked with a point (⊙).]

States.	Sizes of farms (acres).								
	3 to 9	10 to 19	20 to 49	50 to 99	100 to 174	175 to 259	260 to 499	500 to 999	1,000
Indiana	+	+	−	−	+	+	+	−	⊙
Illinois	+	+	−	−	+	+	+	−	⊙
Iowa	+	+	−	−	+	+	+	−	⊙
Wisconsin	+	+	−	−	+	+	+	−	⊙
Michigan	+	+	−	+	+	+	+	⊙	⊙
Ohio	+	+	−	⊙	+	+	−	⊙	−

The table shows that the two smaller sizes of farms are increasing in numbers in all six of the States specified. These small farms are undoubtedly mostly truck and fruit farms and hence are organized in an entirely different way from those devoted to the standard field crops. These small farms are not as numerous in this division of States as they are farther east, but are increasing practically everywhere to some extent, to meet the growing demands of the cities for fruit and vegetables.

The next two sizes of farms are decreasing in numbers. They are too large for gardens and not large enough for farms under the average conditions prevailing in these States. In the older States to the east these two sizes are on the increase for the reason that there the problem of suitable organization of these intermediate-sized farms has been better worked out.

The next three sizes, including farms of 100 to 500 acres, are all increasing in these corn-belt States. This is because their size lends itself to easy organization on economic lines with the enterprises that are best adapted to that region.

Farms larger than 500 acres are either not increasing in numbers or are actually decreasing. These figures well illustrate the fact that farms either smaller or larger than those we have here called normal-sized farms are difficult to organize satisfactorily and consequently have not generally been so successful as the better organized normal-sized farms.

The acreages in Table II are for the whole farm, including a good deal of land not actually farmed. The census data do not give the area of land actually under cultivation on these farms, but it is

known to be somewhere near two-thirds of the areas given in that table.

In this region of corn, wheat (or oats), and timothy and clover the 125 to 160 acre farm is not only increasing in numbers more rapidly than any other size, but it already constitutes by far the most numerous group in most of these States.

The problem of the farm of intermediate size (20 to 99 acres) is an exceedingly interesting one. When such a farm, with, say 40 to 50 acres of arable land, is devoted to the ordinary farm crops, it utilizes neither the farmer's time nor his equipment to its full capacity. In order to make such farms profitable it is necessary either to add some such industry as dairying or to substitute for part of the field crops more intensively worked crops, such as fruit and vegetables. These types of farming find their opportunity largely in the vicinity of large cities; hence, we naturally find farms of this size in the older States near the great market centers.

REDUCING THE COST OF PRODUCTION.

The full utilization of equipment is an important means of reducing the cost of production, since it reduces the amount of equipment necessary. The average farm horse in the Northern States works only three hours a day. This is because the system of management on the average farm is so poorly planned that at certain times the work is very heavy, while at other times there is nothing to do. It is necessary to keep horses enough to meet the needs of the farm when the work is heaviest, but at other times these horses are idle. The average cost of horse labor on the farm under these conditions is about 10 cents an hour. With a well-planned cropping system that distributes the farm labor equally throughout the season it is possible to get six hours' labor per day out of the horses. When this is done the cost of horse labor per hour is reduced to 5 cents.

Many a $12 plow is used to plow not more than 10 acres a year. At this rate the cost per acre for the use of the plow is about 18 cents. When the same plow is used to plow 40 acres a year the plow cost per acre is reduced to about 5 cents, or less than one-third what it is when the plow is used on only 10 acres. Approximately the same thing is true of all other items of equipment. On poorly planned farms the equipment cost is excessive because each item of equipment is used to less than its capacity. For the reason that the equipment must be sufficient to do a great deal of work in rush periods the amount of equipment on poorly managed farms must be much larger than on well-managed farms where there are no rush seasons. On the latter type of farms the work is well distributed, so that no great amount of it must be done at the same time, thus making possible a minimum of equipment.

These are all arguments for well-planned systems of farming. One of the greatest strictly farm-management problems is that of working out such systems in all sections of the country for farms of all sizes and types.

THE FARM GEOGRAPHY.[1]

Another chapter under the general heading "Organization and equipment of the farm" relates to the layout of the farm, or its subdivision into fields, pastures, wood lot, farmstead, etc. No extended discussion of this phase of the subject will be given here, since the title of this chapter is self-explanatory. Reference to it is made here to show its place in a logical arrangement of the subject matter of farm management. The subdivision of the farm into fields is determined largely by the type of farming and the particular enterprises constituting the basis of the farm business. The topography of the land, especially where it is more or less hilly, is also a factor. The size and shape of the farm also help to determine the most suitable arrangement of the fields.

THE FARMSTEAD.

The location of the farmstead, i. e., the group of farm buildings and the yards, lots, garden plat, and kitchen orchard that naturally accompany them, depends on the size of the farm, the location of near-by roadways, the topography of the land, and the prevailing direction of the wind. Since this bulletin is not a treatise on farm management, but rather an outline of that subject, and since the pertinence of this part of the subject is easily apprehended, no further discussion will be given here of the factors determining the location of the farmstead or of the plan of arrangement of its various parts.

FARM EQUIPMENT.

FACTORS OF PRODUCTION IN AGRICULTURE.

The factors of production are classified by economists as land, labor, and capital. This classification is not satisfactory in the consideration of agricultural production for the reason that land itself represents the larger part of the farmer's investment and hence must be considered as a major item of his capital. Furthermore, in practice a different classification of the equipment necessary in agricultural production is well established. For purposes of taxation and in the buying and selling of farms it is customary in this

[1] Many valuable suggestions relating to this and other farm-management subjects may be found in Bulletin 236 of the Bureau of Plant Industry, entitled "Farm Management: Organization of Research and Teaching," by W. M. Hays, Andrew Boss, A. D. Wilson, and Thomas P. Cooper. 1912.

country to divide farm property into real estate and personal property. It will therefore be most satisfactory in discussing the subject to follow the classification of farm property already in general use. Accordingly, we may classify the factors of production into the following three general groups, with their subdivisions as indicated:

I. Real estate, or the land and its permanent improvements.
    Land.
    Dwellings.
    Other farm buildings.
    Fences.
    Drainage systems.
    Water supply.
II. Personal property, or the working capital.
    Live inventory.
        Work animals.
        Other live stock.
    Dead inventory.[1]
        Implements and machinery.
        Circulating capital.
            Supplies and stores, such as feed, seed, fertilizers, unmarketed stock and crop products, fuel, etc.
            Cash (or credit) used for current expenses.
III. Labor.

Of these factors, land is properly considered under the second subdivision of the subject of farm management, i. e., "Selection of the farm." The remaining factors all belong properly under "Farm equipment," which is logically a part of the subject of farm organization. No attempt will be made in this brief presentation of an outline of the general subject of farm management to discuss each of these factors in detail. A brief discussion of the cost of farm dwellings is given merely to illustrate the general method of attacking problems relating to farm equipment.

COST OF THE FARM DWELLING.

How much money can the farmer afford to put into his dwelling? At first thought this question seems to admit of no definite answer because of the number of factors entering into the case, but it does admit of a perfectly definite answer, as will be seen.

The average cost of farm dwellings is controlled by two opposing forces. One of these is the pride of the farmer and his family and the natural and commendable desire for the comforts of life. This force tends to raise the cost of the dwelling. On the other hand, the farm income must suffice not only to defray the expenses of running the farm, but also the living expenses of the farm family.[2] The farm income must also, in the long run, build the dwelling. If

[1] "Dead" is used in the sense of inanimate. This is the term always used in German textbooks on farm management.

[2] Cases in which the family has other sources of income are not here considered

too much money is expended in erecting a dwelling, then the sum available for defraying the expenses of the farm and the farm family will be reduced to the point of being inadequate. The exigencies of meeting farm and living expenses therefore represent a counter force which tends to lower the cost of the dwelling. In the study of farm equipment, instances have been found in which the farmer had expended so large a sum on his house that he was seriously handicapped in the management of his farm because he could not afford to buy much-needed implements and machinery.

In the long run, i. e., on the average of a large number of cases, the point of equilibrium between these two forces will represent the proper cost of the farm dwelling, or rather a cost that to exceed would be unwise. Studies of this subject have been made in several parts of the country and the results have always been the same. The average cost of the farm dwelling is equal to the annual sum available for the living of the farm family, including that portion of the living represented by supplies obtained from the farm; in other words, it is equal to the net farm income for one year. There are probably sections of the country where for special reasons, such as depreciation of farm values or the decadence of agriculture, this rule does not hold, but it will probably be found to hold quite generally where agriculture is in a stable condition and where farmers generally have no other source of income than their farms.

Most of the other classes of farm equipment lend themselves to study in the same manner as do farm dwellings. The Office of Farm Management is now devoting a great deal of time to such studies, and the results should be of much value to farmers.

In the matter of farm labor, which is listed as one of the factors of production, the discussion of the amount of labor needed under different conditions in farming belongs properly here under farm organization. The management of labor is treated later in connection with farm operation.

FARM ADMINISTRATION AND OPERATION.

SYSTEMS OF OPERATION.

The first question to be decided in undertaking the administration of a farm is the system of operation to be adopted. The principal systems are:

(1) Proprietary system—
Operation by the owner and his family, with or without additional hired labor.
(2) Managerial system—
Operation by hired labor managed by the owner or a hired manager.
(3) Tenant system, with or without supervision—
Share tenants.
Cash tenants.
(4) A combination of two or more of the above systems.

In rural economics these various systems of operation are considered from the standpoint of the community or the State. The effect of each system on the character of citizenship and the general economic effect of the wide adoption of any system would be considered by the economist. In farm management we are interested in these systems from the standpoint of their practicability under given conditions and from the standpoint of their effect on the income of the owner of the farm. This includes their effect on the fertility of the soil, since this is an important factor in making the farm profitable. From the viewpoint of the farm manager the question is, What system of operation is most practicable under my conditions, which will give the largest net income, and what effect will the system have on the future yielding power of the soil?

TENANT FARMING.

The most important feature of tenant farming from the farm-management viewpoint is the character of the contract between landlord and tenant. This is a very real problem to every one who rents land, either as owner or as tenant. The owner naturally wants all he can get for the use of his land and its improvements; the tenant just as naturally wants all he can get for his labor. The one great fundamental point on which all other details of the contract hinge is the proportion of the income of the business that should go as remuneration to labor and the proportion that should go as interest and depreciation on the invested capital. When this point is once determined it is an easy task to work out the remaining details, no matter what proportion of the working capital is furnished by landlord and tenant, respectively.

The proportion of the farm income that should go to labor will vary with the type of farming and with the fertility of the soil. This point is now under investigation by the Office of Farm Management, and it begins to appear that it will be possible to arrive at a few general principles that have very wide application and that will furnish a satisfactory solution for this vexed problem.

Aside from the division of income between labor and capital, the most important feature of the contract is the length of tenure for which it provides, though this is not usually considered as important as it really is. On this point depends very largely the effect of tenant farming on the fertility of the soil. With the usual form of lease contract the short-term tenant has no financial interest in what the farm may be able to produce after his lease expires. He is interested in getting out of the land all it will produce now, and does not care very much whether the soil is left in better or in worse condition than before. On the other hand, the long-term tenant

has an interest in the future yielding power of the soil. Short-term tenantry is highly undesirable from every point of view. This difficulty might be obviated, as it now is in England under the Agricultural Holdings Act, according to which a tenant on giving up a holding must be remunerated for any unexhausted improvements he may have made during the life of his lease, when these improvements have been made with the consent of the landlord.

Whether the contract between the landlord and the tenant shall be reduced to writing or shall merely consist of a verbal agreement is a question to be determined by the circumstances of each individual case. In some cases one method is best and in other cases the other. Space will not permit detailed discussion of this point.

It is assumed that the landlord shall furnish the land with the necessary permanent improvements and that the tenant shall furnish the labor. Aside from this, the principal points to be covered in a lease contract are as follows:

Items of working capital (supplies and movable equipment, including both live and dead inventory) to be furnished by each party.

Share of each party in the income of the farm or the amount of rent to be paid and the conditions of payment.

Items relating to soil management, including restrictions as to the cropping system to be used, the amount and kind of live stock to be kept, and the method of utilizing crop products.

Repairs of permanent equipment.

Length of tenure.

Tenant's privileges, such as keeping cows, pigs, and poultry, raising garden truck, and the use of supplies from the farm, including fuel.

Amount of supervision by the owner.

The general method of investigating this whole problem is that outlined in treating of the farm dwelling. It consists of a careful study of actual contracts all over the country, with special attention to the satisfactoriness of the various details, both to landlord and to tenant. A contract that enables the landlord to secure and keep a desirable class of tenants is taken to be satisfactory from the standpoint of the tenant; one that does not satisfy good tenants and under which they decline to remain after having had experience with it is considered unsatisfactory.

The cost and character of tenant houses, as well as their location with reference to the main dwelling, are subjects of some importance in farm operation and would receive attention in a treatise on farm management.

While it seems probable that tenant farming will increase as the value of farm land rises in this country, it is hoped that the work of the agricultural scientist may serve in some measure to counteract this tendency.

HIRED LABOR.

The subject of hired labor as a part of the general subject of farm management takes up such questions as the supply of farm labor and the sources of this supply; wages and the methods of paying them, both to regular employees and to temporary day laborers; profit sharing; housing and boarding laborers; the laborer's privileges, such as the use of horses and vehicles, holidays, and trips to town, access to papers and books, and the social status and welfare of farm laborers from the standpoint of securing continued service from desirable laborers.

In the management of labor it is important that the manager have accurate knowledge of the standards of farm labor. If both manager and laborer understand this matter the management of labor is greatly simplified. Hence, in the management of labor it is well not only for the manager to inform himself on this subject but to make use of such data on the subject as are available as a means of educating the laborers he directs concerning what may fairly be expected of them. No one has a moral right to demand that the laborers under his direction shall work at a rate that would impair the working power of the laborer, but with this limitation the manager has a right to expect the best service the laborer can give.

THE WORK SCHEDULE.

On a farm that has a definite cropping system, and in fact on any farm as soon as the plans for the season are definitely made, it is possible to make out at least a rough schedule of the work to be done during each month of the coming season. A very good plan is to divide each month into three periods, the first and second periods being 10 days each and the third the remainder of the month, which will make the third period 8, 10, or 11 days according to the length of the month. A chart can then be made having the dates in the left-hand column and the various crops or other enterprises for the headings of the remaining columns. Under each heading may be inserted in each 10-day period the work to be done on that particular enterprise during that period. It will, of course, not be possible, on account of the vagaries of the weather, to follow such a schedule blindly, but at the same time the schedule will be of great service in keeping track of the farm work. It is especially helpful as a means of foreseeing what equipment as well as what teams and men will be needed at particular times and this enables the manager to be prepared for work at the time it should be done.

Such a schedule is also helpful in the management of labor, especially of those who are inclined to shirk. If the schedule is based

on generally recognized standards of farm labor the laborer who fails to keep up with it is thus shown to be not doing efficient work.

It is also a good plan in connection with the work schedule, or even where no definite schedule is maintained for the ordinary field work, to keep on hand a list of things to be done at times when, on account of the weather, the field work is interrupted.

CARE AND UPKEEP OF EQUIPMENT.

This part of the subject deals with such questions as keeping implements and machinery in repair and protecting them from the weather; the importance of having implements in order when the necessity for using them arises, instead of waiting until they are needed, and thus causing delay in their use; methods of keeping track of the supplies and the importance of having things on hand when needed, instead of having to stop work and waste time in going to town to get them; the losses occurring from careless handling of small tools and minor items of equipment, and methods of preventing such losses; the repair of farm buildings and their protection from fire; the importance of keeping drainage systems in repair; the principal difficulties that arise in connection with such systems and how to avoid or meet them; and the management of the water supply.

FARM BOOKKEEPING.

The keeping of records of the farm work and business transactions is a very important part of farm administration. It is true that many farmers, even successful ones, do not keep any formal records, but this does not mean that they know nothing of the status of their business. When the business is not extensive or complex most farmers are able to carry the details in their heads sufficiently well to answer practical purposes. But when the business is large and complex, and especially when it involves a good many running accounts with parties with whom business is transacted, more or less formal record making becomes quite essential.

The leading classes of farm records, each of which would receive more or less consideration in a treatise on farm management, are the inventory, the financial accounts, the labor records, the performance records (such as milk records of individual cows, etc.), the feeding records, cost accounting, the record of supplies, the weather record, and the breeding records.

PURCHASING SUPPLIES.

There are a few general considerations relating to the purchase of supplies and farm necessities that should be set down in a treatise on farm management. Some of these are the advisability of buying for

cash, the saving by buying in quantity, the value of promptness in meeting obligations, etc. In a mere outline of farm management it is unnecessary to enter into details in the discussion of these considerations.

MARKETING PRODUCTS.

This is another subject that requires no extended mention in an outline of the subject of farm management, but should receive due consideration in a complete treatise on the subject. The necessity of putting up in an attractive manner any farm product that is to be sold directly to retail customers in the form in which it leaves the farmer's hands is so obvious that it ought not to need discussion, yet when one goes to market and sees unsorted and unattractive apples and potatoes exposed for sale beside the products from farms that send only attractive wares to the market, it seems that farmers have not yet generally learned this lesson. The unwisdom of trying to market perishable farm products, such as the softer fruits and truck crops, through unknown and unrecommended commission merchants in distant cities, who have every chance to practice fraud without let or hindrance, ought also to be so self-evident as to prevent anyone from relying on such methods of marketing; but the facts indicate that many have not learned this lesson, and some farmers apparently need to have the lesson repeatedly brought to their attention.

STORAGE AND CARE OF FARM PRODUCTS AND SUPPLIES.

The depredations of insects and vermin on stored farm products in some sections are serious. Methods of preventing these depredations are of importance to the farm manager. Losses from exposure to the weather, especially in the case of such products as hay and fodder, are also subjects to be considered in discussing farm operation.

CROP AND SOIL MANAGEMENT (APPLIED AGRONOMY).

The difference between the farm-management point of view and that of agronomy, relating to crop management, has already been pointed out. Farm management includes the application of the principles of agronomy in business. It also includes the application in practice of the principles of soil management, if, indeed, soil management is not to be considered simply a phase of crop management.

In actual practice it is frequently necessary to depart from the teachings of the agronomist, for the reason that to give each crop the care which the agronomist has shown to be desirable from the standpoint of the individual crops is not always feasible. Thus, it may be desirable to use both oats and corn in a rotation, in which to give the oats the best possible opportunity is incompatible with the

interests of the more valuable corn crop. There is little doubt that on the average oats will give better yields if the soil is plowed and put in excellent condition before the oats are sown. But to do this would greatly reduce the area of land that could be made ready for corn, since these two crops compete with each other for labor at the same season of the year. But if the oats are disked in on corn stubble without any previous preparation of the land, experience has shown that they do fairly well in some sections, and, since this can be done before the soil is in condition to plow, the full quota of oats can by this means be sown in the rotation without interfering with the preparation of the soil for corn. In farm management, therefore, we are not only interested in knowing what are the best methods of crop and soil management from the standpoint of securing maximum yields, but also what the result will be when departures must be made from the practice that would give maximum yields.

The maintenance of soil fertility is one of the most important problems confronting the farmer, at least in the older farming regions, and will ultimately be everywhere. We know very well that plenty of barnyard manure will build up infertile soil and maintain fertility in an already rich soil. But not every system of farming provides sufficient manure for this purpose. When manure is not available or is available in insufficient quantity provision must be made in most sections for some other means of keeping up yields. These other methods are much less well understood than the method of using manure. Provision can usually be made for supplying humus by growing catch crops at various points in the rotation practiced and by plowing under as much as possible of the refuse of the crops grown, especially the stubble of perennial hay crops. But this alone generally will not suffice, so that in default of abundant manure it is usually necessary, except in the more newly settled regions, to resort to the use of commercial fertilizers. It is an interesting question which the next generation of farmers may have to face, What will take the place of commercial fertilizers when the supply of phosphates and potash salts is exhausted?

One of the very important farm-management studies is to work out the relation between all kinds of practices to the maintenance of soil fertility. This problem is amenable to study by the experimental method, but the study of farm practice where applicable is not only cheaper and quicker but rightly conducted is much more accurate than the ordinary field-plat experimentation because of the much greater mass of data and the greater certainty that the results obtained will be applicable to actual farm conditions. This study should include the farm methods of managing manures as well as farm practice in the use of catch crops and of commercial fertilizers.

LIVE-STOCK MANAGEMENT (APPLIED ANIMAL HUSBANDRY).

Animal husbandry bears the same relation to farm management as does agronomy. In farm management we are interested in the application in practice of the principles of animal husbandry. Farm-management investigations do not properly include experimental work in either agronomy or animal husbandry, but they do include farm-practice investigations in both these subjects. It is one thing to discover a scientific fact in the laboratory and a very different thing to work out its application in practice. It is the latter phase of these two sciences that is of direct interest in farm management, and this phase can only be studied by the actual investigation of farm practice.

In farm management both crop and live-stock management are considered especially from the standpoint of complete systems and the bearing these systems may have on the remainder of the farm work.

STUDY OF SUCCESSFUL FARMS.

For the reason that many principles of farm management can only be studied in farm practice, the careful farm student or manager will study those that are distinctly successful. The student will learn much that can not well be set down in books and formal lectures, and the farm manager will find in the experience of others the solution of many problems that arise in practice that are never thought of in the classroom.

It is difficult to formulate definite plans for the study of actual farms. No two farms are alike, and a set of blank forms intended to bring out the salient points in the management of a particular farm will seldom suffice for another farm. Such studies should begin by getting a general view of the system of management in vogue on the farm. A very good plan of procedure is to get first a statement of the cropping system, including the acreage and yield of each crop usually grown, the rotation practiced, if any, and the use made of each crop. Then may follow a statement of the system of management of each crop, including complete details regarding the use of manures and fertilizers, the dates of plowing and seeding, the number of cultivations, etc., for each crop. Next may follow similar treatment of each type of live stock on the farm. After this, if any technological processes are followed, a complete account of them should be obtained. In obtaining an account of any enterprise the aim should be to secure a statement of every operation performed, the season of the year when it is performed, the amount of work it requires, and the equipment used in this work, including the number of men and horses and the kind and sizes of implements used. When departures from ordinary practice are met with it is always well to learn the owner's reasons for such departures, for this may lead to

the discovery of something of value in farm practice. Finally, a statement of the equipment of the farm as a whole should be obtained; also as accurate an account as possible of the annual expenses and receipts by enterprises. The blanks used by the Office of Farm Management or those used by Cornell University in making detailed farm-management surveys will be found very useful in studies of this kind, but they do not cover all the points that should be covered in making a thorough study of a successful farm for the purpose of learning from it all the lessons it has to teach. It is not possible in a farm-management survey to study each farm in such detail as the best farms justify.

MANAGERIAL EFFICIENCY.

The final chapter of a treatise on farm management may well relate to the training and the personal characteristics that contribute to managerial efficiency. The corporate principle in business has been successfully applied everywhere except in agriculture. Generally speaking, large agricultural undertakings have not been successful, principally because suitable managers have not been available. Managers have been lacking partly because the principles of farm management have not been worked out and definitely stated, and the business is too complex for the average man to become a successful manager of a large undertaking simply through experience alone. When these principles are once clearly stated, there seems to be no reason why large farms should not be even more successful, financially, than small ones. Whether it is desirable from the standpoint of national economy for the small farm to give place to the large one is a question of rural economics and does not directly concern the science of farm management. Such changes are controlled by economic forces that work in spite of our attempts to counteract them. If large agricultural undertakings could be made as successful as those of moderate size are now sometimes made, there is every reason to believe that corporate agriculture would assume an important rôle in this country, whether or not it is desirable that this should be the case.

II.—THE WORK OF THE OFFICE OF FARM MANAGEMENT.

INTRODUCTION.

Science is sometimes defined as knowledge methodically formulated and arranged in a rational system, or, to express it more briefly, classified knowledge. In Part I of this bulletin the attempt has been made to present an outline of the science of farm management, in so far as the knowledge of the principles of this science is available, and to point out the principal deficiencies in this knowledge. Farm management is a new science and the facts in this field of knowledge are as yet imperfectly known. Hence the urgency of farm-management investigations.

In organizing scientific research we may divide the branch of science under investigation into its logical subdivisions and assign investigators to each of these subdivisions, or we may organize it on the basis of methods of investigation. In the organization of the research work of the Office of Farm Management both of these methods are recognized. In the main, the subdivision of the work is based on methods of investigation, but in the various sections of the office the work is to some extent divided along the lines of the subject matter investigated. In practically all efficient organizations for scientific research this dual type of organization exists, as it does to a marked degree in the general organization of the Bureau of Plant Industry, of which the Office of Farm Management is a part.

The object of Part II of this bulletin is to present an outline of the organization and work of the Office of Farm Management, with sufficient discussion to make clear the methods of investigation followed and the purposes to be attained.

It should be stated that the Office of Farm Management developed out of the old Office of Grass and Forage-Plant Investigations. Later a new office under the latter title was organized and most of the work relating to grasses and forage plants was transferred to this new office. There were, however, a few lines of work on these crops which for various reasons were left in the Office of Farm Management. These are included in the outline below for the sake of presenting the work of the office in its entirety.

The work of the Office of Farm Management is divided into five sections, as follows:

(1) Office administration and records.
(2) Farm economics.
(3) Special farm-management studies.
(4) Farm-management field studies and demonstrations.
(5) Utilization of cacti and dry-land plants.

The work of each of these sections is discussed briefly below, but with sufficient fullness to enable the reader to gain a clear idea of the nature and purpose of the work and the methods pursued.

OFFICE ADMINISTRATION AND RECORDS.

This section is responsible for the care of the library and the various files maintained in the office, such as correspondence and field reports of the staff; for the preparation and care of photographic records; for the revision of manuscripts; and for the financial records of the office.

FARM ECONOMICS.

The subdivision of the work in the Section of Farm Economics is based partly on methods of investigation and partly on subject matter. The various types of investigation in progress are agricultural cost accounting, farm-management surveys, farm equipment, marketing farm products, agricultural credit, agricultural insurance, and history of farm management.

AGRICULTURAL COST ACCOUNTING.

Several methods, differing more or less in details, are used in cost-accounting work in the Office of Farm Management. One of these is as follows: Detailed records of all labor performed and of all transactions occurring on a considerable number of farms are received in the office and tabulated in such manner as to show the cost and income of each enterprise on the farm, as well as the general farm expenses which can not be charged to any particular enterprise. This renders it possible at the end of the year to determine the profit or loss from each enterprise, as well as of the farm as a whole.

In this work the Office of Farm Management is cooperating with the Ohio Agricultural Experiment Station, the University of Wisconsin, and the University of Missouri, the records from farms in these States being received and tabulated at the institutions mentioned and copies of the tabulations being transmitted to Washington. The records from farms located in other States are received and tabulated in the Office of Farm Management. The original records are made by the men who do the farm work, on blanks furnished by the Office of Farm Management and the cooperating institutions. Monthly summaries of the labor by enterprises are furnished the owners of the farms, and at the end of the year they are also fur-

nished a complete summary of the records for the year, showing the cost and income for each enterprise and for the farm as a whole.

Another method differs from the foregoing in the fact that the farms furnishing the records are located in a selected locality and are visited at frequent intervals by a representative of the office whose business it is to render such service as may be necessary in keeping the records, and especially to see that the records are properly made. These groups of farms are known as cost-accounting circuits. A representative of the office devotes his whole time to the 15 to 20 farms constituting one of these circuits.

In cooperation with the New York State College of Agriculture at Cornell University the office employs a man who devotes his time to helping a number of farmers in the State of New York to develop systems of bookkeeping for their own use. These systems include cost-accounting records the tabulation of which is done by the farmer himself.

The Office of Farm Management also furnishes to several hundred farmers well distributed over the country a special form of diary, in which the farmer keeps such records as he desires and from which he makes such tabulations as he wishes. Suggestions are made to the farmer as to the records it is worth while to keep and the tabulations that would be of most service. Instructions are also given as to the details of record keeping and the making of tabulations. These books are furnished with the understanding that when they are filled (each book holds six months' records) they will be lent to the Office of Farm Management for the purpose of securing therefrom any data that may be useful in connection with the work of the office. Experience with these diaries has shown that they give much valuable data concerning the cost and income from farm enterprises and still more concerning the dates when various farm operations occur. This latter information is of special value in studying the important question of the seasonal distribution of labor on the farm. Perhaps the most important service they render the office is in showing what records farmers can be induced to keep when it is made easy for them to make the records and the use that farmers will make of such records when they are at hand. The results thus far have been very gratifying.

In the types of cost-accounting investigations just described the work has related to the whole farm. The office also conducts cost-accounting investigations relating to a single enterprise. In this work representatives of the office visit a large number of farms on which the enterprise under investigation is conducted and secure from each the data concerning every feature of the conduct of the enterprise. The data thus obtained represent either the farmer's knowledge of the details of the conduct of the enterprise or the best estimates he is able to make concerning them. The relative accu-

racy of information obtained in this way as compared with that obtained from detailed records kept by farmers, as well as with data obtained in ordinary experimental work, will be discussed later in these pages.

The original purpose of the cost-accounting work was to determine the cost of all classes of farm operations and the relative profitableness of the various crop and live-stock enterprises under different conditions, as well as to develop simple systems of accounting adapted to the farmer's own use. The many important lessons the results of these investigations have taught will be dealt with in other publications. Suffice it here to state that the causes of profitableness have been found quite as often in the scheme of organization of the farm as in the excellence of the methods used, if, indeed, not more often. The fact has been strongly emphasized that a proper selection of enterprises that fit well together, thus giving a satisfactory seasonal distribution of labor, and especially a system that gives full utilization of the farmer's ability, that permits the maximum wise use of power and at the same time so distributes the work as to render necessary a minimum amount of equipment, greatly reduces the cost of production per unit of product, and thus increases the profit in farming. Without such a system there is frequently little or no profit, no matter how well the work of the farm may be done. Thus it happens that while these investigations have resulted in valuable knowledge of the kind originally sought, they also furnish a vast array of facts that are of even greater value than a knowledge of the cost of doing things on the farm.

The following is a partial list of the subjects on which the records obtained in the cost-accounting work furnish data of more or less value:

Kind and number of operations required by every enterprise.

The dates when these operations may or must be performed.

The character of crew (men, horses, and machinery) required for each operation.

The amount of work these crews perform in a day, and hence the time required for each operation.

The proportion of days in a given period that are available on the average for field work, or, to state this conversely, the proportion of time lost from rain, holidays, necessary trips to town, unavoidable delays, and the like.

Cost of production and income from the various farm crops and types of live stock under a wide range of conditions.

The general farm expenses, or the "overhead charges," on the productive enterprises of the farm.

The returns per hour of labor spent on different enterprises.

The amount of use, and hence the cost per acre and per unit of product, of each item of equipment.

The rate of depreciation of farm equipment of all kinds. This is determined in two ways: (1) From the successive annual inventories and (2) from the

length of time an implement lasts and the amount of work it does. This second method is, of course, possible only on farms for which records are secured for a number of years.

Length of the working day.

Time required for "chores" on farms of different sizes and types.

The relation of all phases of farm practice to crop yields.

The practicability of various crop rotations.

The conditions to which various farm enterprises are suited.

The relative profitableness of different enterprises.

Crops which compete and those which do not compete for labor at the same time of the year.

Relation of the size of farm to profit.

Relation of the type of farm organization to profit.

The cost of marketing farm products.

The rate of income on capital invested in farming.

The labor income of the farmer.

Distribution of capital between the various factors of production, such as land, buildings, fences, work stock, productive stock, implements and machinery, etc.

Cost of housing and feeding farm animals.

Cost of horse labor.

Cost of man labor.

Types of records adapted for use by the farmer.

It is clear, therefore, that these investigations cover practically the whole field of farm management. But unfortunately the securing of complete records of all the work done on a large number of farms is both tedious and costly. It would require many years and the expenditure of vast sums of money to secure all the data needed on farm-management subjects in this manner. Some of the kinds of data in the above list can be obtained in no other way, but many of them can be secured in greater quantity by cheaper methods, as will appear in the accounts of other types of investigation described in what follows.

FARM-MANAGEMENT SURVEYS.

Another important line of investigation conducted by the Section of Farm Economics is the farm-management surveys. In this work localities are selected that are believed to be representative of important agricultural regions and studies are made on every one of 500 or 600 contiguous farms, no farms being omitted from which it is possible to obtain the necessary data. These surveys are intended to reveal the actual status of the agriculture of the regions in which they are made.

Sufficient data are obtained from each farm to enable the investigator to determine the amount of capital invested, the value of all the major items of equipment, the amount and character of the farm expenses and receipts, the increase or decrease in the farm inventory for the past year, and all other facts necessary to determine the labor income of the farmer after deducting interest on the

investment and wages for the unpaid labor done by members of the farmer's family other than the farmer himself.

The data obtained also permit the study of such questions as the relation of profits in farming to the education of the farmer, the relation of the age of the farmer to the percentage of tenant farming, the effect of distance from markets on the value of farm land, and numerous other questions of importance to agriculture in general.

Some very important results have been obtained in studies of this kind and some time-honored opinions on matters of importance have been shown to be erroneous. Detailed results of these surveys are published from time to time in the series of bulletins issued by the Bureau of Plant Industry, and it is therefore unnecessary to discuss these results at length here.

A word as to the accuracy of the results obtained in these surveys. The data obtained from the farmers represent their knowledge, and in cases where they do not have definite knowledge, their estimates as to the details of the farm business during the year just past. It sometimes happens that it is possible to test the accuracy of the results thus obtained. This was the case in one detail of a recent survey made by this office in one of the New England States.

Among the several hundred farms included in the survey were 135 that sold milk to creameries. Each of these farmers was asked to give as accurate an estimate as possible of the amount of money he had received for this milk. After the survey was partially finished it occurred to the investigator that it would be possible to secure a check on the accuracy of these estimates by obtaining the actual figures from the creameries themselves. It was decided also to test in a similar manner the farmers' estimates of the quantity of milk each had sold to the creamery. The estimates as to quantity of milk sold were then obtained from the 79 farms visited after the decision had been reached to make this test. These farmers did not as a rule weigh their own milk and were not accustomed to dealing with weights as they were with sums of money; it was to be expected, therefore, that the estimates of quantity of milk sold would be less accurate than those of money received, and this was the case, as will be shown below. After obtaining the estimates from the farmers, the actual figures, both for weights of milk sold and for money received, were secured from the creameries that had purchased the milk.

Estimated pounds of milk sold (79 farms)	3,518,816
Actual pounds of milk sold (79 farms)	3,487,320
Difference	31,496
Estimated value of milk sold (135 farms)	$106,163.00
Actual value of milk sold (135 farms)	106,155.50
Difference	7.50

It is seen that the error in the quantity of milk sold is a little less than 1 per cent of the whole. At the same time the individual estimates of pounds of milk sold were in error by amounts ranging from 40 per cent above to 36 per cent below the correct figures. In the total these errors tended to counterbalance each other, so that the sum of the estimates was quite accurate. In the estimates of money, in terms of which the farmer is accustomed to reckon, the error in the total is less than one-hundredth of 1 per cent. These instances will serve to show something of the measure of accuracy attainable in the results of the farm-management surveys. There is, however, another source of error in such data that is more important. The data obtained apply only to the season in which the survey is made; the results therefore may not represent average conditions in the regions studied. The only way of obviating this difficulty is to repeat the work for several seasons in the same region, and this will be done in all cases where there is reason to believe that the conditions are abnormal during the year in which the first survey is made in the locality.

The relative accuracy of results obtained by gathering data from experience and from data obtained in plat experiments deserves further notice here, in view of the fact that the type of investigation represented by the study of farm practice has not been much used hitherto and its value is not yet fully appreciated by students of agricultural problems. It is unnecessary to dwell on the inherent inaccuracies of plat experiments, especially those due to unavoidable causes, such as the variation of soil in adjacent plats and the variations in seasons which affect different plats differently. In judging the accuracy of final results where these results represent averages of a number of separate observations or measurements two questions are to be considered, i. e., the number of observations involved in each average and the accuracy with which the original observations or measurements were made.

It is a well-established mathematical principle that, other things being equal, the reliability of an average increases as the square root of the number of observations included in the average. From this standpoint the method of investigation by the study of farm practice has a very distinct advantage over that of plat experiments on account of the vastly larger amount of data that can be obtained with a given expenditure of time, energy, and money, assuming, of course, that the problem is one that has actually been worked out in farm experience, whether those who have worked it out are aware of the fact or not.

The relation of the accuracy of the final average to the accuracy of the original observations is a matter that is often overlooked in experimental work, and consequently a great deal of effort is wasted

by attempting to secure great accuracy in one of the controlling factors in the case when the results are rendered inaccurate by inaccuracy in others. A chain is not made stronger by strengthening the link which is already strongest. If great variation in the yield of a crop, for instance, is due to irregularities of the soil and to variations in seasons which affect different plats differently, then no great increase in the degree of accuracy in the final result is obtained by using extreme care in measuring areas of plats and yield per acre. This point is illustrated in figure 1.

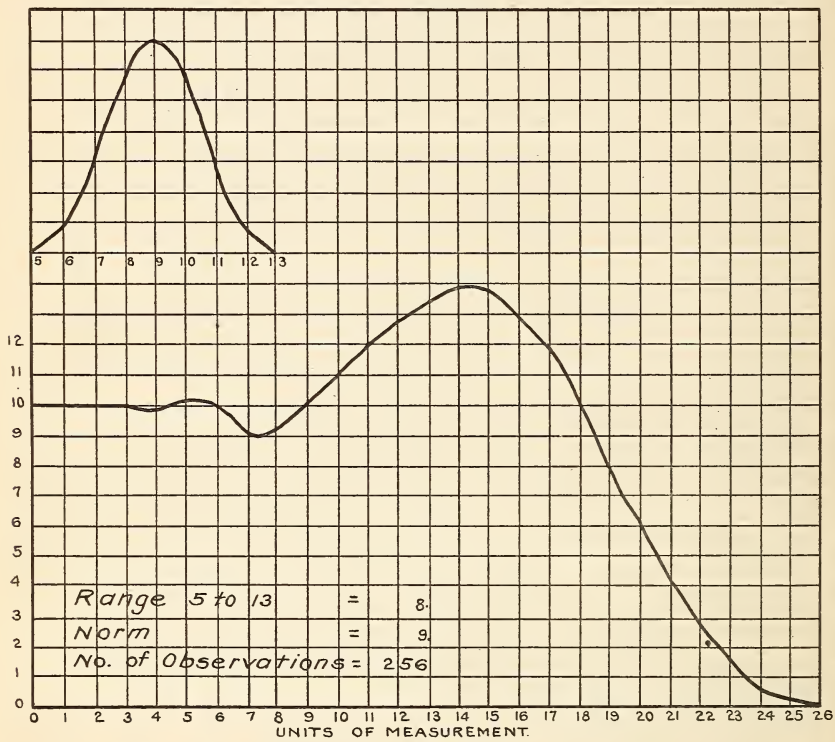

FIG. 1.—Diagram showing the relation of the accuracy of an average to the accuracy of the numbers averaged.

The upper curve in this diagram is a frequency curve for a series of 256 observations of a variable quantity whose range of variation is from 5 to 13 on the scale adopted in the diagram. This degree of variation is comparable to that of the yield of a crop in plat experiments covering a series of years or a series of plats side by side the same year. The true average of the 256 observations in this case is 9. If instead of the true values of the observations, made originally, say, to the second decimal place, we take in each case the nearest unit, the average is still 9, as shown in the lower curve of the diagram. In this lower curve the figures at the bottom (abscissas)

represent the units of measurement used in making the observations to be averaged, and the ordinates of the lower curve show the corresponding averages. It is seen that the inaccuracies of the averages are too small to represent in the diagram until the unit in which the measures are made reaches the magnitude of three divisions of the scale, which is three-eighths of the whole range of variation of the variable. In other words, we make no essential gain in accuracy of the final average by making the original observations more accurately than to use a unit equal to three-eighths of the range of variation.

It should be stated that this conclusion does not apply to all kinds of averages, but it does apply to those cases in which the observations form a frequency curve of approximately the form shown in the diagram (upper curve). This means that in determining the average yield of a crop that varies from year to year by as much as 24 bushels per acre, when the number of experiments is large, we make no appreciable gain in accuracy by using a unit of measurement smaller than 9 bushels. Thus, if any yield between $4\frac{1}{2}$ and $13\frac{1}{2}$ is recorded as 9, yields from $13\frac{1}{2}$ to $22\frac{1}{2}$ as 18, from $22\frac{1}{2}$ to $31\frac{1}{2}$ as 27, and so on, the final average, if the number of yields in the average is considerable, will be approximately as accurate as if the yields had been determined to the hundredth part of a pound per acre. In other words, when the number of observations is large, a series of guesses by those who can make reasonably good guesses gives a result about as reliable as the most accurate measurements when the quantity to be measured or considered is highly variable. On account of the importance of this matter and the fact that these principles are not generally understood except by students of the theory of probabilities, further illustration of them is given below.

In the American Naturalist for April, 1909, Dr. R. Pearl, of the Maine Agricultural Experiment Station, shows that in the measurement of the length of 450 hen's eggs to the nearest millimeter only the average of these measurements is correct to the nearest hundredth of a millimeter; i. e., the average was more accurate than the measurements on which it was based.

Again, the mean annual rainfall at Philadelphia for a period of 66 years, from 1826 to 1891, inclusive, was 43.2 inches, the measurements being made to the nearest tenth of an inch. At the end of the first 10 years of these observations the annual mean was 40.4 inches. There is no doubt that the mean for 66 years is more nearly the true value of the mean than that for 10 years. Taking the 66-year mean as the true value, the 10-year mean is in error to the extent of 2.8 inches. If, now, instead of the true value of the rainfall each year we take the nearest 10 inches, so that, for instance, any rainfall between 25 and 35 inches is recorded as 30 inches, the

average thus obtained for the 66 years is 42.9 inches, an error of less than 1 per cent of the true average, while the 10-year average from accurate measurements is in error over 6 per cent. Not only that, but the 66-year average when precipitation is recorded to the nearest multiple of 10 inches agrees more closely with the 66-year average made from records reading to the tenth of an inch than does the average of any of the 10-year periods during the first 60 years of this time, even when the data on which the 10-year averages are computed is highly accurate. This shows that in securing the average value of a variable quantity the number of observations is more important than precision of measurement.

Enough has been said to show that data collected from farm experience, if sufficiently abundant—and they can easily be made so—give results even more dependable than the results of the ordinary plat experimental work. Data so obtained compare favorably with the best plat experiments when the subject under investigation is adapted to this method of investigation.

Farm-practice results secured by this method relate to real farm problems, which can not always be said of experiments planned in the experimenter's office.

FARM EQUIPMENT.

While the cost-accounting work was primarily intended to determine the cost and profit of farm operations, we have seen that incidentally it furnishes much valuable information relating to practically every phase of farm management. The farm-management surveys, while not covering so wide a range of subjects, still cover a good part of the field. These two divisions of the work represent different methods of investigation rather than different fields of investigation. On the other hand, the investigations relating to farm equipment represent one of the subdivisions of the science of farm management as outlined in Part I of this bulletin. The methods used in the investigation of equipment problems are closely similar to those used in the farm-management surveys, though they are more detailed than the latter, much more time being given to the equipment of a given farm or enterprise. The data regarding equipment are in the main obtained by personal visits to the farms studied, careful inventories of the various items of equipment being made.

The factors which determine equipment are, in many instances, numerous, variable, and complex, for which reason the necessary or justifiable equipment for given conditions can, in many cases, be ascertained only through experience. At the same time such wide variation exists in practice that the true resultant of the forces which control equipment can only be found by considering a large number

of cases, for it is necessary to have large numbers of observations in order to secure reliable averages. Hence, methods that are more rapid and less expensive than those used in the cost-accounting work are better adapted to the solution of the main problems of farm equipment. The method already outlined (see p. 29) for ascertaining the proper or permissible cost of the farm dwelling illustrates well the general method of attacking the more complex problems relating to farm equipment. We can not solve such a problem simply by determining the number of individuals to be housed and the number of cubic feet of inclosed space each requires, for people differ in taste both as to the amount of space needed for each individual and as to the appearance of the inclosed space, viewed either interiorly or exteriorly. We can, however, ascertain how much it is safe financially for the farmer to expend in inclosing this space. But the forces that determine this limit of safety are subtle ones that can not be measured directly; we can only measure their general resultant by taking the averages of large numbers of cases.

Similarly complex and subtle forces determine many other features of farm equipment, though in many cases it is possible to determine equipment needs more directly from the definite relations existing between character of equipment and the nature of the thing to be accomplished. Thus, when a system of cropping on a farm is once determined, it is possible, in many cases at least, to state at once certain items of equipment that will be necessary, or at least highly desirable, in carrying out this system. But if a farm has 20 dairy cows, 10 head of young stock, 5 work horses, and 40 ewes, it is not so clear just what buildings this complement of stock necessitates or what these buildings should cost. It is possible, by taking account of the stock to be sheltered and the amount of feed for them that must be stored, to determine quite accurately the amount and character of the inclosed space needed; but how much money the farmer would be justified in putting into these structures must be determined in another way. Many farmers would settle such a question by building the cheapest structures that would answer the purpose, even inadequately. Others would desire more adequate, and even ornate, structures. An actual census of the farm buildings on farms having the above complement of stock would undoubtedly show a variation of 200 or 300 per cent or more in the cost of the buildings in use. In building a cow barn, for instance, it is possible to secure shelter for the cows and their feed at a cost per head of less than $2, though perhaps not adequate shelter. Yet cow barns exist in this country that cost over $2,000 per head for the animals sheltered. What sum is the farmer justified in putting into such a structure? This is a question that can be answered only by a careful study on a large number of successful dairy farms. The fact that a farm is successful

is evidence that in such matters it has not far transgressed the limits of prudence on the one hand or of adequacy on the other. The study of actual practice on a large number of successful farms is thus the best means of arriving at the solution of many of the problems relating to farm equipment.

A few farmers are able to determine quite accurately their needs in the way of equipment, but the vast majority of them make more or less serious mistakes. Especially is this likely to occur when the farmer changes his type of farming and takes up one or more enterprises with the equipment of which he is not familiar. A great deal of money is wasted in equipment that is not needed or is not suited to the purpose it is intended to serve. On the other hand, many farmers obtain poor results for lack of suitable equipment, and this is not always because they can not afford to buy the needed equipment, but because they do not know what they need. Because of these facts the Office of Farm Management has undertaken to ascertain what is adequate and satisfactory equipment, so far as this is possible, for the conduct of farms of all sizes and types in all sections of the country. The mere fact that the actual equipment in use for accomplishing the same thing varies widely on different farms does not present an insurmountable obstacle in the investigation of this question, though it does make the problem difficult. It is, however, rendered much more complicated by the fact that changes in the type of farming are continually going on in nearly all sections of the country. But the fact that these changes are going on makes the work all the more urgent.

The following is a brief outline of the more important subjects under investigation relating to farm equipment:

Distribution of capital between the various factors of production: The relative amount of capital invested in land, buildings, work animals and other stock, implements and machinery, supplies, and ready cash for current expenses on farms of different sizes and types in different climatic regions.

The farm dwelling: Its cost, peculiarities of farm dwelling as contrasted with city dwellings, interior arrangement, design, and construction.

Other farm buildings: Amount and character of inclosed space needed under given conditions; space units per animal; the arrangement of the inclosed space in relation to convenience and economy; the location of buildings with reference to each other and to the farm as a whole; farm practice in design and construction of farm buildings and the principles involved in the same; the cost of buildings under all conditions; the cost of keeping buildings of different types in repair; and the rate of depreciation of buildings.

Farm fences: Conditions requiring or justifying fences; relation of the layout of the farm to economy in fencing; types of fences and their uses; the cost of fences of different types; the cost of materials for all kinds of fences; the amount of labor required in constructing fences; the cost of keeping fences in repair; and the rate of depreciation of farm fences.

Water supply and sewage disposal on the farm: Types of equipment and cost and practicability of the same.

Systems of heating and lighting farm buildings and the cost of installing and operating the same.

Equipment of farms of a particular type.

Relation of the size of the farm to the character, especially the size, of the equipment.

Equipment for particular enterprises.

General farm equipment: Equipment that can not be charged directly to any one of the productive enterprises of the farm. Equipment of this kind accounts for part of the general farm, or "overhead," expenses, which must be apportioned between the productive enterprises in determining the profit of these enterprises.

Minor items of equipment: This includes those small items that are never, or at least seldom, enumerated separately in the farm inventory, but are lumped together under the general title "small tools, etc." One important study of this kind has already been published. (See Circular 44, Bureau of Plant Industry, entitled "Minor Articles of Farm Equipment.")

Equipment for particular operations: This includes a study of the wide variation in farm practice in performing the same work and of the causes underlying this variation; the cost of a given operation when performed with different equipment; and a complete study of crew work of all kinds, including the number of men and horses in the crew, and the number, kinds, and sizes of implements or machines used by the crew, as well as the part each member of the crew plays in the operation.

Duty of machinery: This is a study of the amount of work a machine or implement does, or should do, in a given time, such as an hour, a day, or a working season.

Standards of farm labor: A study of the amount of labor that may fairly be expected of a farm laborer under all conditions and in all kinds of farm work. Data of this kind are of enormous value in the management of hired labor, as well as in planning in advance a season's work or in making out a working plan for a farm.

The proportion of time available at different seasons of the year for work of different kinds, especially for field work.

The amount of labor and the number of work animals needed on a given farm at different seasons of the year.

Equipment charges: The rate of depreciation of farm equipment of all kinds; the cost of repairs; the cost of housing implements and machinery; the rate of interest on money invested in equipment of different kinds; and the amount of annual use of equipment and its bearing on the equipment cost of farm operations.

The conditions, especially the amount of use, that justify the purchase of a given item of equipment; conditions which make hiring more desirable than the purchase of equipment.

Advantages and disadvantages of joint ownership of the more expensive machines and implements.

Use of mechanical power instead of horse power on the farm. (See Bulletin 170, Bureau of Plant Industry, entitled "Traction Plowing.") Attention is given to types and sizes of tractors in use; conditions to which the various types are best adapted; conditions which justify the purchase of a tractor; the original cost, the cost of repairs, and the rate of depreciation of farm tractors; the cost of operation and the crews and supplies required; the amount of work done per day and per season; and the cost per unit of work done.

The Office of Farm Management receives numerous inquiries as to the relative merits of different makes of implements designed for the same work. These are problems in farm engineering and are not strictly farm-management problems. To answer such inquiries would involve long and painstaking research, requiring extensive laboratory equipment, necessitating exhaustive inquiry into methods of mechanical design, construction and efficiency, the strength and adaptability of materials, etc., all of which are lines of work requiring a different education and training and a different point of view from that of farm management. It would also involve complications with the patent laws if undertaken under Government auspices. This fact and the further fact that such investigations might involve conflicts with private inventors and manufacturers who are spending much time and money in such investigations have hitherto operated to prevent the appropriation of public funds for the study of such problems. But the opposition of manufacturers to investigations of this character has largely disappeared, and would entirely disappear if such modifications of the patent laws could be devised as would both protect the inventor and at the same time give every manufacturer the privilege, under proper supervision and control in the interest of the inventor, of using any patented device that would improve the articles manufactured by each. Even at the present time manufacturers would quite generally welcome public engineering laboratories and test stations that would furnish data as to the mechanical types that would be best adapted to farm needs in the various agricultural sections of the country. Such investigations would save both the farmer and the manufacturer millions of dollars now wasted in poorly designed and constructed machinery.

HISTORY OF FARM MANAGEMENT.

Ancient and medieval literature regarding farm management, while by no means extensive, is yet sufficient to enable the careful student to gain a fair idea of economic conditions in agriculture at most stages in the history of European nations. This is especially true of Italian agriculture during the days of the Cæsars and of English agriculture practically from the time of the Roman occupation, near the beginning of the Christian era. In the period during which the Romans produced their most enduring literature it was fashionable for scholarly men to own country estates, and no small amount of literature is extant relating to the management of these estates. It has always been fashionable for the English nobility to own land and to farm it. Even in the early centuries of the Christian era it was the custom on country estates in England to keep fairly complete records of farming operations. A careful

study of this old literature is being made in order to summarize for publication such of it as will interest farmers.

The three subjects following belong to rural economics rather than to farm management, but are investigated in this office on account of their intimate relation to the subject of farm management, as well as for administrative reasons.

MARKETING FARM PRODUCTS.

A study is made of the methods used in different parts of the country in preparing farm products for market, especially those that go to the ultimate consumer in the form in which they leave the farm, with special reference to the effect these methods have on the prices received; methods used in transporting farm products, especially perishable products, to distant markets, and the relation of these methods to market values; methods of organizing and conducting cooperative marketing associations; the effect these associations have on the net returns received by the farmer; the distribution of enterprises with relation to the market centers; and finally the difference between prices received by the farmer and those paid by the consumer and the reasons for this difference.

AGRICULTURAL CREDIT.

An investigation is made of the sources of available credit for the farmer, the conditions under which the farmer may obtain credit for financing his operations, and the rates of interest on farm loans. It also includes a study of the details of organization and operation of agricultural loan associations, both in America and in Europe, with special reference to those features which adapt these organizations to American conditions.

AGRICULTURAL INSURANCE.

This is a study of forms of insurance most patronized by farmers, and especially of farmers' mutual insurance societies, their organization and conduct, and the rates of insurance paid. Attention is given to life, fire, crop, live-stock, and all other forms of insurance, but especially to those forms conducted by farmers' mutual organizations.

SPECIAL FARM-MANAGEMENT STUDIES.

In conducting farm-management field studies the country may be divided into geographic sections and men assigned to each of these sections for the purpose of studying the farm-management problems that present themselves, as is done in the Office of Farm Management in the case of the broader and more fundamental problems, or men may be assigned to a particular problem without restriction as to the

territory covered, being guided in this matter by the geography of the problem itself. In this office this latter method is pursued in the case of problems which, however important they may be, are not of sufficient magnitude to justify assigning more than one or two men to their investigation or which are only distantly related to the major problems of farm management. These problems are here brought together under the above heading. Some of them are inherited from the old Office of Grass and Forage-Plant Investigations, out of which the Office of Farm Management developed, and were left in this office when the new Office of Forage-Crop Investigations was organized, either because of the personal interest of certain members of the staff in the problems in question, because they involved certain phases of farm management or because there was no other office in the Bureau of Plant Industry that was directly interested in them. Some of them, however, relate strictly to fundamental problems in farm management. These special problems follow.

TENANT FARMING.

The lack of further opportunity for taking up desirable public lands in our Western States and the consequent general rise in the price of farm lands practically all over the country has resulted in an increase in tenant farming, especially in those sections where land values have risen to the point at which it is exceedingly difficult for the purchaser of a farm to meet both living expenses and interest on his indebtedness and also make payments on the principal. It can hardly be doubted that tenant farming will further increase in this country and that ultimately the land will largely be owned by the wealthier classes and be farmed by tenants with moderate capital.

It is to be hoped that the work which the National Government and the States are now doing for the benefit of the farming classes will ultimately enable a larger percentage of farmers to own the land they farm; but the problems relating to tenant farming are not only important at the present time, but are likely to become more so. Two phases of the subject are receiving special attention in this office at the present time. One of these relates to the amount of working capital required to conduct a farm properly, especially with a view to maintaining the fertility of the soil, and the possibility of inducing the landlord to furnish this capital where the tenant is unable to do so. The other relates to the details of the contract between landlord and tenant. Both the cost-accounting work and the farm-management surveys, as well as the farm-equipment studies, furnish much valuable information on the first of these two problems, but it is also receiving direct study as a separate problem by a careful study, especially of those tenant farms that are being conducted in a satisfactory manner.

Sufficient discussion has already been given the problem of the contract between landlord and tenant (pp. 31–32) to give the reader an idea of the phases of the subject that are under investigation. Investigations thus far conducted indicate that the central problem in the contract is the share of the farm income that is to go as reward for labor and the share that shall constitute the income on capital invested. On certain large estates that have for many years been let to tenants and on which the securing of satisfactory tenants is a major problem this problem of labor's share of the farm income has been quite definitely solved, that is, it has been worked out what proportion of the income must go to labor in order to secure and hold desirable tenants. There are many such estates in this country, one of them consisting of 200,000 acres of as good land as the country affords. The results of these investigations will be given in separate publications. (See Farmers' Bulletin 437, entitled "A System of Tenant Farming and Its Results.")

RELATION OF GEOGRAPHIC FACTORS TO THE DISTRIBUTION OF FARM ENTERPRISES.

Types of farming and farm enterprises generally find their proper place in the agriculture of any country. But the process, unaided by science, is slow and exceedingly expensive. Millions of dollars have been wasted by the farmers of this country in finding out what crops, types of live stock, and farm-factory processes are adapted to each of the various agricultural sections of the country. Very little serious attempt has been made to ascertain what are the real limiting factors in the distribution of these enterprises. The Office of Farm Management is undertaking a general study of the relations existing between the distribution of enterprises and such geographic factors as the amount of rainfall, the seasonal distribution of rainfall, the length of the growing season, the dates of the last frost in the spring and the first frost in the fall, and the topography, elevation, latitude, geological formation, and character of the soil.

CLEARING AND UTILIZATION OF LOGGED-OFF LAND.

There are yet many millions of acres of land to be cleared for farming. This is mostly land from which all the merchantable timber has been cut; hence the designation "logged-off land." Much of this land has lain unused for many years because of the expense of removing the stumps from the ground. Now that free land ready for the plow is practically a thing of the past, these logged-off lands assume an importance they did not possess a few years ago.

The study of the problems of clearing and utilizing logged-off land, though not strictly a subject for farm-management investiga-

tions, has been carried on by the Office of Farm Management for reasons already suggested, and this office is investigating the methods in use in the various sections of the country where these lands are being put into cultivation, as well as studying problems connected with the improvement of these methods. (See Bulletin 239, Bureau of Plant Industry, entitled "Cost and Methods of Clearing Land in Western Washington.")

RELATION OF FARM PRACTICE TO CROP YIELDS.

Probably more effort has been given to the attempt to learn how to increase crop yields than to any other single problem in agriculture. While much has been learned, we are yet far from having a satisfactory understanding of this most important subject. All over this country, at least in the older settled sections, there are farms on which definite systems of farming have been followed for a sufficient length of time to permit the system to have produced whatever effect it will on the fertility of the soil. The Office of Farm Management is engaged in gathering up careful records of these systems, especially those that give satisfactory crop yields, with a view to studying, by means of comparison of the different systems and the resulting yields, especially those under similar climatic and soil conditions, the effect different elements in the systems have on the yield of crops.

FARM MANAGEMENT IN SUGAR-BEET CULTURE.

The different viewpoints of farm management and agronomy with reference to a crop were fully discussed on page 14. In the case of sugar beets the agronomist is concerned with the methods to be used in order to produce the greatest tonnage of available sugar per acre. The investigator in farm management is concerned with the equipment required for the production of beets, with the labor necessary and the distribution of this labor during the season, and also with the relative profitableness of this crop as compared with others to which the farmer might devote his land; in short, with the economic conditions which render sugar beets a desirable farm enterprise. Studies of this character are in progress, in cooperation with the Office of Sugar-Plant Investigations.

Exactly similar studies are being made of all the leading farm crops of the country, but for the most part these studies are made incidentally in connection with the farm-management field studies to be described later in this bulletin.

WEEDS AND TILLAGE IN RELATION TO FARM PRACTICE.

Farm practice in weed control and in the matter of tillage is more closely related to the work of the Office of Farm Management than to that of any other office in the Bureau of Plant Industry, for which

reason this work is conducted in this office. It is a line of work which developed out of the attempt to find a method of eradicating Johnson grass, which attempt was entirely successful (see Farmer's Bulletin 279, entitled "A Method of Eradicating Johnson Grass") and thus represents an inheritance from the old Office of Grass and Forage-Plant Investigations. While both lines of work (weed control and tillage) are studied mainly from the standpoint of farm practice, some experimental work is conducted on both of them.

The distinctive method of weed investigation developed in this office consists of a detailed study of each weed for the purpose of ascertaining its complete life history, especially the methods of propagation possible to it. The season of the year at which seeds, rootstocks, bulbs, and other parts capable of originating new plants are formed, as well as the stage of growth the mother plant must reach in order to be able to form these propagating parts, and the length of life of any part of the plant capable of originating new individuals are accurately determined. In the case of most perennial weeds thus far investigated this knowledge has pointed to certain easy methods of eradication. Thus, in the case of Johnson grass, the weedy character of which arises from the freedom with which it produces rootstocks, the rootstocks do not begin to form until about the time the plant has reached the blossoming stage. If the plant is cut back, as in mowing hay, before the rootstocks are formed, the energies of the plant are then directed toward throwing up new aerial growth instead of the development of rootstocks. If the plants are kept cut back during the whole season rootstocks do not develop until late in the season, and then only feebly. It is only these newly formed rootstocks and the crowns of the old plants (and, of course, the seeds) that will give rise to new growth the next year. A single very shallow plowing late in the season, after the plants have been cut back so as not to allow them to produce blooms during the summer and before the rootstocks have made more than the merest start to form, thus completely destroys the plant and leaves no means of propagation for the following season. By taking advantage of these facts clean crops of cotton have been grown on land from which Johnson-grass hay had been cut the previous season. Similar studies have been made of wild onion and of quack grass, and easy methods for the eradication of both of these pests have resulted (see Farmer's Bulletin 464, entitled "The Eradication of Quack-Grass," and Circular (Document 416), Bureau of Plant Industry, entitled "The Wild Onion").

Particular attention is now being given to the relation of weeds to the various crop rotations practiced in different sections of the country.

Investigations of farm practice in the methods of tillage in all parts of the country are in progress, the object being to ascertain what are the fundamental causes of present practices, as well as the bearing of economic conditions on methods in use in different sections. Is the 15-inch sweep used for cultivating cotton in so many parts of the South due to the meager amount of power necessary on a one-man cotton farm or is this implement actually the best type of implement to accomplish the purpose for which it is used? Some recent results of tillage experiments conducted in this office seem to indicate that implements of the type (but not necessarily of the size) of the sweep are, in fact, the logical implements to use for tillage of crops like cotton and corn. These investigations point very strongly to the conclusion that the object of cultivation on soils that are well filled with growing plant roots is not to create a mulch but to kill weeds. If this is true, the sweep, or scrape, may be the best implement now available for the tillage of growing crops.

The methods used and the results obtained in these tillage experiments are given in detail in another publication (see Bulletin 257, Bureau of Plant Industry, entitled "The Weed Factor in the Cultivation of Corn").

FARM-MANAGEMENT FEATURES OF HAYMAKING AND THE UTILIZATION OF THE HAY CROP.

The farm-management features of haymaking relate to the amount and kind of labor required and the season of the year when this work must be done. They also include the cost of producing hay and the best manner of utilizing the crop as a source of revenue on the farm. One other feature of haymaking that is receiving attention is methods and cost of curing hay by artificial heat. The labor distribution on the hay crop is, of course, studied from the standpoint of farm practice. The work on artificial curing is experimental. This work is slow and expensive, and it will be some years before positive results can be announced. (See Farmers' Bulletin 508, entitled "Market Hay.")

PASTURES AND CROPPING SYSTEMS FOR LIVE STOCK.

The study of problems relating to the maintenance of pastures and the place of pastures in the economy of the farm was begun in this office before it was converted into the Office of Farm Management, and certain phases of this study are still continued in cooperation with the new Office of Forage-Crop Investigations. A study of the practice of those stock farms which maintain pastures in productive condition is being made. Problems relating to the renovation of worn-out pastures are under investigation in cooperation with the office last mentioned. Special attention is being paid to the cropping systems used on successful stock farms in all sections of the country.

FARM-MANAGEMENT FIELD STUDIES AND DEMONSTRATIONS.

RELATION TO THE FARMERS' COOPERATIVE DEMONSTRATION WORK.

In the cotton-producing States, including Virginia, North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas, the work of the Section of Farm-Management Field Studies and Demonstrations of the Office of Farm Management is confined to the investigation by the study of farm practice of problems relating to farm organization and farm operation, all the demonstration work in these States being conducted by the Farmers' Cooperative Demonstration Work, which constitutes a separate office in the Bureau of Plant Industry. Although this investigational work is conducted in close cooperation with the Farmers' Cooperative Demonstration Work, the two are administered independently. In other States this section of the Office of Farm Management conducts both investigations and demonstration work, and no effort is made to keep the two types of work separate, the same staff conducting both.

ORGANIZATION.

In the administration of the work of the Section of Farm-Management Field Studies and Demonstrations of the Office of Farm Management the country is grouped into three divisions, as follows: The North Atlantic and North-Central States, the South Atlantic and South-Central States, and the Western States. The second of these divisions includes the cotton States, in which, as above stated, the Office of Farm Management does no demonstration work, and, in addition, includes the States of Delaware, Maryland, West Virginia, and Kentucky, in which the office conducts both investigations and demonstrations. It is probable that as the demonstration work of the office grows the first of the divisions specified will be separated into two. A division leader has charge of the work in each of the foregoing groups of States. Another assistant to the section leader has charge of the boys' and girls' agricultural club work in all the States except those in which the Farmers' Cooperative Demonstration Work is organized. In these States the latter office has charge of this work.

Each of the geographic divisions mentioned is subdivided into groups of a few States each, and the division leader has an assistant in each of these groups of States. These assistants are known as district leaders. They devote their time mainly to the investigation of farm practice, but assist in the supervision of demonstration work. In the cotton States their whole time is devoted to investigational work. The investigational work conducted personally by the leader of this section of the office, by the division leaders, and by the district leaders is not conducted in direct cooperation with State agencies.

But all demonstration work conducted by the office and such investigations as are conducted by those in local charge of the demonstration work are conducted in cooperation with State agencies in the manner outlined below wherever it is possible to arrange for such cooperation.

The recent development of the demonstration work conducted by this section of the Office of Farm Management has made necessary an extension of the foregoing plan of organization in order to provide adequate supervision of the demonstration work and to facilitate cooperation in this work with State agencies. The general plan for this extension of the organization of this section of the office is outlined below. This plan is modified as occasion requires to suit the exigencies of the institutions in cooperation with which the work is done.

A State leader who has general charge of farm-management field studies and demonstrations in the State is employed jointly by the United States Department of Agriculture and the cooperating institution, the salary and expenses of this man being paid jointly by the two parties to the cooperation. It sometimes happens that when the work is first instituted in a State only one of the cooperating institutions is provided with the necessary funds. In such cases the institution having the funds bears the expense until such time as the other can secure funds for this purpose. At the inception of this work in a State it also sometimes happens that the number of men employed as county demonstrators is small and the State man has been permitted to work entirely for the State institution for a portion of the year, usually devoting his time to the teaching of farm-management subjects, the entire salary of the man during such employment being paid by the State institution. But this arrangement is in all cases looked upon as temporary, for with the full development of the investigational and demonstration work the entire time of the State man will be required for its supervision and conduct.

The plan of organization of the work under the direction of the State leader is as follows: Local agents are stationed in the various counties of the State and are made responsible for the conduct of demonstration work and the investigation of local problems in the county. The salaries and expenses of these local men are borne jointly by the Department of Agriculture, the State, and the county, assisted by organizations or individuals who may be interested in the work. In cases where the State or county can not provide funds for this purpose the expenses are borne jointly by the department and private organizations or individuals. In the past the local funds have been provided partly by the county and partly by chambers of commerce, farmers' organizations, banks, railroads, and individuals who are interested in the development and improvement

of the local agriculture. In several States the legislatures have empowered the county authorities to appropriate funds for this work.

The counties in which local agents are employed are grouped together into districts of about 10 counties each, with a supervisor at the head of each. The county men report to and work under the direction of these supervisors, who in turn are under the direction of and report to the State leader. Where State or local funds are available for the purpose, the salaries and expenses of the supervisors are paid jointly from these State or local funds and funds from the Department of Agriculture; otherwise the department provides the funds.

Copies of all results obtained in the investigation of farm practice, as well as all records of demonstration work done and results obtained by the State leader and the staff working under his direction, are furnished both to the cooperating State institution and to the Department of Agriculture. The character of both the investigational work and the demonstration work to be done in any case is agreed upon by the parties to the cooperation, and the State man in charge works under the joint direction of a designated representative of the cooperating State institution and the division leader in the Office of Farm Management. The cooperating institution furnishes office facilities to the State man, and similar facilities are furnished to the county agents by the counties or by local organizations or individuals. The local agents devote most of their time to demonstration work and comparatively little time to investigational work. The time of the supervisors is more largely devoted to field studies. State men and the division and district leaders devote their time to the investigation of farm-management problems by the study of actual conditions existing on the farms in their respective territories and to the supervision of the demonstration work.

OBJECTS.

The objects to be accomplished by the work of the Section of Farm-Management Field Studies and Demonstrations of the Office of Farm Management may be briefly stated as follows:

(1) To carry to the farmer the results of scientific research in his behalf, as well as the results of the experience of other farmers, and to aid the farmer in applying these results in his work.

(2) To reorganize and redirect the agriculture of the various sections of the country in such a way as to secure on each farm not only enterprises that are profitable in themselves, each being so conducted as to bring maximum net returns, but also to secure a system of enterprises that will permit the largest economical use of power, capital, and labor possible under the conditions, and which will give as nearly as possible an even distribution of labor and a full utilization of equipment throughout the year.

In this section of the office the results of the investigations of other sections of the office, as well as of other offices of the Bureau of Plant Industry, find their final application on the farm through the work of local agents engaged in extension work.

PROBLEMS AND METHODS.

The investigations of the Office of Farm Management have shown that the principal factors of profitableness in farming are as follows:

(1) Character of the enterprises constituting the basis of the farm business.
(2) Amount of power used per individual employed.
(3) Amount of capital employed.
(4) Distribution of capital between the factors of production, such as land and buildings, work stock and other animals, implements and machinery, etc.
(5) Amount of labor (profitably) employed.
(6) Seasonal distribution of labor and maximum utilization of minimum equipment.
(7) Systems of management of the individual enterprises.
(8) Methods of marketing.

The selection of enterprises that are to constitute the basis of the farm business has been considered quite fully in the first part of this bulletin. (See pp. 9–14.) A summary of the factors which determine what enterprises are adapted to given conditions is given on page 13. A great deal depends upon the wisdom with which the selection of enterprises is made. The study of this question is a very important part of the work of those connected with this section of the office. This is especially true of the work of the county agents; the supervisors who have charge of groups of counties; and especially of the district leaders, who have charge of a group of States. Very frequently it will occur that some crop or some type of live-stock farming is well adapted to a general region but not well developed in that region. In such cases it is an important part of the work of this section of the office to develop this enterprise. (See "Types of Farming in the United States," Yearbook U. S. Dept. of Agriculture for 1908.)

In doing this, great circumspection must be used. In the first place, it must be certain that the enterprise is well adapted to local conditions. Another very important point which must be considered is the probable effect upon the markets of a large increase in any enterprise. As was stated earlier in this bulletin, those enterprises which represent the principal crops and types of live-stock farming of the country may usually be largely increased in a given limited territory without disturbing the supply and demand to any noticeable degree; but enterprises which are themselves only a small part of the agriculture of the country, such as beans, hops, and even potatoes, which so far as soil and climatic conditions are

concerned are enormously less developed than they might be in this country, should not be encouraged to such an extent as to threaten great overproduction. In regions that are more or less segregated from the general markets this applies even to enterprises that are largely developed in the country as a whole. In such regions the district leaders especially should make it a part of their duty to determine what the possibilities are in the way of marketing a largely increased product of any kind before the effort is made to increase production to any considerable extent. District leaders should read carefully what is said on pages 9 to 14 on this subject.

In determining the enterprises that are to be encouraged in a given region careful attention should be paid to the relation of crops to soil types. Supervisors and county agents especially should give attention to this matter. Very frequently it will be found that one variety, say, of corn is adapted to rich bottom land while another variety in the same general region is adapted to the thinner uplands. In general, attention should be given to the character of the local varieties that are grown and the relation of these varieties to the various types of soil occurring in the region.

In many parts of the country efforts are being made to introduce new crops. For instance, alfalfa is being tried by farmers all over the country. Soy beans are also under experiment very generally on farms in the eastern part of the United States. In recommending any new crop to the farmer the soil requirements of this crop should be thoroughly understood, as well as the effect it will have upon the seasonal distribution of labor on the farm. Both soy beans and cowpeas have had some difficulty in finding a place on farms in the eastern United States because of the fact that they require a good deal of labor at the same time as corn, and hence interfere to some extent with the seasonal distribution of labor. All these questions should be taken into account in recommending any new enterprise to the farmer.

The relation of the amount of power employed per individual to profit in farming has been quite fully discussed in the comparison of one-man cotton farming with one-man wheat farming. (See pp. 17–23.) In the first of these types of farming the man utilizes only one work animal, and this one not to its full capacity. In the other, one man usually uses five horses and keeps them busy during nearly the whole season for field work. By referring to the data given on page 20 it is seen that the average labor income on the cotton farm where the farmer owns his land is about $260 a year, while on the wheat farm it is about $1,560. These two types of farming also illustrate the relation between the amount of capital employed and the profit. The cotton farmer employs very little capital, and his capital income is less than $100. This, of course, will vary with conditions.

On the other hand, the capital income of the wheat farmer is over $1,000 per year.

One of the important problems under investigation in this section of the office is the number of horses which it is practicable for one man to use in all kinds of farm operations in all sections of the country. District leaders are instructed to give particular attention to this problem, but county agents and supervisors should also make observations on this point whenever the opportunity offers. In the wheat-growing sections of the State of Washington one man utilizes the power of from four to six horses in nearly all kinds of field operations. Is a similar practice feasible in other sections? A recent farm-management survey in the State of Illinois developed the fact that teams of four and five horses are common in that section, and the labor income of the farmers there is more than twice as great as it is in other regions where smaller teams are used.

In this connection particular attention should be given to the possibility of uniformity in the size of equipment from the standpoint of the number of horses employed. Thus, if a farm is large enough to justify employing four horses, would it be advisable to have practically all of the work on the farm done by four-horse teams and thus save the time of one man?

The place of mechanical power on the farm is being investigated in connection with the farm-equipment studies already outlined. (See p. 51.) Bulletin 170 of the Bureau of Plant Industry, entitled "Traction Plowing," deals with this subject.

The relation of profitableness in farming to the amount of capital employed, to the distribution of this capital between land, buildings, and other factors of production, and to the number of laborers employed are subjects that are studied largely in connection with farm-management surveys and farm-equipment investigations, which are conducted in another section of the office. (See under "Farm economics," pp. 40–53.) The results of such studies are utilized to the fullest extent in connection with demonstration work, which relates as much to the redirection and reorganization of agriculture as it does to the conduct of farm work.

In regions where farming is not generally profitable because the holdings are too small for the types of farming adapted to local conditions, farmers should be encouraged to increase the size of their holdings either by purchase or by leasing. It is also a part of the duty of those engaged in demonstration work to give information to farmers concerning the amount it is wise to invest in dwellings and other farm buildings, the number of work horses that could be profitably used, and the character and quantity of machinery and other equipment justifiable under any given conditions. In this connection the information given in bulletins issued by the Section of

Farm Economics of this office is of value. (See Bulletin 212, Bureau of Plant Industry, entitled "A Study of Farm Equipment in Ohio," and Circular 44, entitled "Minor Articles of Farm Equipment.")

The seasonal distribution of labor on the farm and the maximum utilization of minimum equipment which good seasonal distribution of labor renders possible is a subject to which representatives of this section of the office should give attention. (See pp. 14–24; also see the article entitled "Seasonal Distribution of Labor on the Farm," Yearbook U. S. Dept. of Agriculture for 1911.)

In most parts of the country on farms devoted to the ordinary field crops the working season may be roughly divided into the following periods:

(1) SPRING: Preparing land and seeding spring crops.
(2) LATE SPRING AND EARLY SUMMER: Cultivation of intertilled crops.
(3) MIDSUMMER: Hay and grain harvest.
(4) LATE SUMMER AND EARLY FALL: Preparing land and seeding winter crops.
(5) FALL: Harvesting fall-maturing crops (corn, potatoes, cotton).
(6) WINTER: Care of stock, repairing equipment, laying in fuel supplies, cutting timber, mending fences, etc.

Plowing for spring crops may occur during any of the periods 1, 4, 5, or 6.

To have the labor evenly distributed between these various periods increases the proportion of the time during which the farmer is profitably employed and reduces the amount of power and equipment required to farm a given area. It is only in exceptional cases that such even distribution of labor is not important (p. 17). On most farms it is highly desirable, and occasionally a farm will be found on which the seasonal distribution of labor is the critical problem. As stated previously in these pages, most systems of farming which have become general in a region are at least rough approximations to systems that are ideal in this respect. The problem then is usually not that of completely revolutionizing the system which prevails on a farm but rather that of making slight adjustments of the system to render it more satisfactory from the standpoint of labor distribution. Frequently a slight increase in the area of fall-sown crops will relieve the congestion of work in the spring and reduce considerably the number of work animals required on the farm. Sometimes a change in the order of the crops in a rotation will obviate the necessity of plowing some fields, for some crops leave the land in condition for certain others without plowing. Occasionally a farm will be found whose owner has attempted to break away from the current practice in the matter of crop rotation and has established a system that gives exceedingly poor distribution of labor. Such farmers usually see the error of their way after a few years, but they frequently lose not a little money before they realize

what is wrong with the systems they have adopted. Farms of this character may need radical changes in the cropping system in vogue in order to secure a satisfactory distribution of labor throughout the season.

It is desirable that representatives of this section of the office should work out in detail a few systems of cropping, based on the crops commonly grown or that should be commonly grown in their territory, each theoretically perfect from the standpoint of the seasonal distribution of labor. The knowledge gained in working out these systems will well repay the effort required. Such work gives an insight into some of the important problems that arise in the management of the farm. It impresses on the mind what crops compete with each other for labor at the same season of the year and those that do not compete. The working out of a few such systems will enable the student of farm organization to see quickly defects of farm organization when these defects relate to seasonable distribution of labor, which they frequently do. It will also fix firmly in mind the different problems of organization on farms of different size. If the farm happens to be of just the proper size to give adequate employment to one man and two horses when the land is devoted to the ordinary field crops, the problem of its organization is very simple indeed. Attention has already been called to the fact that farms of this size are not only more common in the States of the Middle West than those of other sizes, but that farms of this size are increasing in numbers, while those that are somewhat less in area are decreasing in numbers in those States. On the other hand, in the older States, especially near the great market centers, these smaller farms are increasing in numbers, because there the problem of their proper organization has been worked out. One can hardly appreciate the full meaning of these facts without attempting to work out systems of farming for farms of different sizes with a view to obtaining on farms of various sizes adequate employment for the farmer and the capital, labor, and equipment that might be used to advantage on a given farm.

The attempt to work out cropping systems that give good distribution of labor also reveals the fact that the system of management adopted with a given crop is frequently governed to a large extent by the exigencies of farm operation. Thus, whether the land for a given corn crop shall be plowed in the fall or the spring is determined in practice more generally by the amount of work the system in vogue calls for at each of these two seasons than it is by any theoretical advantage in the matter of yield that would come from plowing at either of these two seasons.

In regions where systems of farming prevail that bring only a meager income to the farmer or are otherwise seriously faulty, as

is the case with the single-crop cotton system of the South, it is necessary to work out systems which differ materially from those commonly found. In the cotton States, for instance, if single-crop cotton growing is best under the circumstances, the problem then is not one of farm organization but is that of securing the highest possible yield, and the principal problem to be solved is that of supplying abundant humus to the soil. But if land is abundant and labor scarce, and especially on farms where the owner and his family do the major portion of the field work, in order to increase the family income materially it is desirable to work out a system of farming that will permit the use of at least 2-horse teams in plowing cotton lands and in cultivating the crop, and then provide other crops which will fully occupy the time of the available labor and horse power when not required by the cotton crop.

The usual rotation recommended for the cotton region is cotton followed by corn, and that followed by winter oats, after which cowpeas are sown as a summer hay crop. But this rotation does not give an entirely satisfactory distribution of labor. If we add to it a fourth year of winter oats and summer cowpeas, or if we substitute for the cowpeas Japan clover (lespedeza) and leave it down two years, we increase the area one man can farm and secure a better distribution of labor during the year.

In order to be able to understand the effect a given enterprise has upon labor distribution it is necessary to be familiar with the details of the management of that enterprise. It is therefore an important part of the work of representatives of this section of the office to familiarize themselves with these details. The following information concerning every kind of farm enterprise should be secured:

(1) The kind and number of operations required by the enterprise.
(2) The dates these operations may or should occur.
(3) The crews (men, horses, and machinery) used in these operations.
(4) The amount of work each of these crews performs in a day.
(5) The percentage of time available for each operation at the season in which it is performed.

These details of enterprise management are highly variable. For instance, the kind and number of operations in growing the cotton crop are different on different farms in the same community and are widely different in different sections of the country. The same is true of practically every other farm enterprise. It is therefore necessary to study these questions broadly and to become familiar with the permissible variations in methods. Some of the problems involved in this study are complex and difficult. This is especially true of the crews used, the amount of work done in a day, and of the per-

centage of time available at different times of the year, especially for field work.

Every representative of this section of the office should study extensively the subject of standards of farm labor. They should read carefully what is said on this subject on pages 14 and 15.

An easy method of determining the percentage of time available for field work during any period of the year is as follows: Suppose it is known that during the months of August and September in a given locality one man with two horses can, on an average, plow, harrow three times, and drill 40 acres of wheat. The percentage of available time may then be found thus:

Time required for 1 acre in various farm operations.

Operation.	Day's work.	Time for 1 acre.
	Acres.	*Part of day.*
Plowing	1.75	0.571
Harrowing (3 times)	10	.300
Drilling	8	.125
Total		.996

It would require $40 \times 0.996 = 39.8$ actual days of work to put in this crop. Since there are 61 days in August and September, the available time is $39.8 \div 61 = 0.653$, or 65.3 per cent—practically 2 days in 3 on an average. The available time at any other season may be found in a similar manner if the area that one man can manage during that season is known. The amount of work he can do in a day must also be known.

In examining the system of management on a farm with a view to determining its weak points it is helpful to tabulate, at least roughly, the labor required by the various enterprises during each of the principal work periods. Where the organization of the farm from the standpoint of the distribution of the labor is faulty this gives an important insight into the nature of some of the problems that confront the farmer. Then, if the field man is familiar with the details of management, especially the labor distribution, of a large number of farm enterprises, it is easy to suggest changes in the system of management which will reduce the amount of work at one period and increase it at another, and this will not only decrease the amount of horse power and machinery equipment needed during the busiest seasons but will give a fuller utilization of horse power and equipment throughout the year. Where a definite system of cropping is in vogue on a farm a well-worked-out labor schedule covering the whole year will be of great assistance to the farmer, and in many cases it is worth while to work out such schedules for individual farmers. They are useful in the management of labor and are

always of value as a means of foreseeing what equipment should be made ready for work in the near future.

Most of the work of agricultural scientists has related hitherto to methods of conducting farm enterprises, and has had little to do with problems relating to farm organization or to the problems that arise in the conduct of the business of the farm. While methods of growing crops and managing live stock are only one of the factors of profitableness in farming they are an important factor. Hence, it is of the greatest importance for those engaged in farm-management field studies and demonstration work to study carefully the methods used by successful farmers everywhere. They should also familiarize themselves with the results of scientific investigations relating to the best methods of conducting all kinds of crop and live-stock enterprises. The methods used by farmers who make a satisfactory profit in farming may usually be safely copied by others unless better methods are known.

An excellent type of work, especially for the supervisors, who have charge of groups of counties, and for district leaders, who have charge of the work in a few States, is to select regions covering a few counties in which the agriculture is fairly uniform, or, if sufficiently uniform, the region may cover a larger area, and to make a detailed study of the agriculture of the region along the lines indicated in the following publications of the United States Department of Agriculture: Farmers' Bulletin 294, entitled "Farm Practice in the Columbia Basin Uplands"; Farmers' Bulletin 472, "Systems of Farming in Central New Jersey"; and Bulletin 215 of the Bureau of Plant Industry, "Agriculture in the Central Part of the Semiarid Portion of the Great Plains."

In such studies particular attention should be given to the prevailing types of farming and the reasons why they prevail, including a discussion of the general adaptability of these types of farming to local conditions. The study should include the cropping systems used, the methods employed in managing the various crops and types of live stock, the methods of soil management and the resulting yields obtained, the sizes of farms, and the general financial condition of the farmer. This work is similar to the farm-management survey work already described, but it gives more attention to the methods used on the farms and covers a much wider territory. Such a study should also include, as far as possible, the history of the changes in the local agriculture, with the causes underlying these changes. Such studies give the field man an excellent knowledge of the agriculture of the region, and when published are exceedingly valuable not only to farmers in general, but also to those seeking locations in which to purchase farms.

Representatives of this section of the office should note, whenever opportunity permits, all cases of by-industries which are not usually found on farms, such as broom making, sirup making, etc., that are used to fill in the gaps in the labor schedule. In connection with such industries an account should be obtained of the equipment and its cost, the season of the year when it demands labor or occupies labor otherwise engaged on the farm, the profit obtained from it, etc.

All representatives of this section of the office are instructed to make a record of all crop rotations found in practice, together with the farmer's reasons for following each rotation, or rather the reason for each of the crops in the rotation and the particular order in which the crops come. Study of this kind over a large area will soon show what is practicable and what is impracticable in the way of crop rotation in that region, especially if it is one in which crop rotation is quite generally practiced.

Similar records should be made of all cropping systems for specific purposes that are found. Thus, in some of the tobacco-growing regions, a rotation is used in order to increase the yield of tobacco. The character of such rotation should be recorded and reported to the office. On stock farms frequently the rotation is planned to meet the needs of the stock on the farm. Such rotations should be studied carefully. In studying any rotation attention should be given to the labor distribution it requires. It is also a part of the work of the representatives of this section of the office to plan cropping systems, either of a general nature or for specific purposes, for such farmers as may desire them.

Another subject for investigation by the representatives of this section of the office is the cost and practicability of different methods of performing the same work. For example, corn may be cut and shocked by hand; by means of a 2-row, 1-horse platform cutter run by two men, with or without an extra man to make the "horses" for the shocks and pick up scattered stalks and ears; or by means of a corn binder with or without a shocker attachment. Wheat may be bound, shocked, and thrashed; bound, shocked, stacked, and thrashed; headed, stacked, and thrashed; or it may be harvested by a combined header and thrasher. Manure may be distributed by hand from a wagon, or it may be distributed by means of a manure spreader. There are many other farm operations that may be similarly performed in a number of ways. The problem is to find the cost of performing the operation in each of these ways and to determine which is most profitable and most practicable under given conditions.

Another problem closely related to the foregoing is that of crew work, which is also studied in the Section of Farm Economics. It is important to study all kinds of farm operations that require a number of men, teams, and implements. For instance, in putting silage in

the silo a study should be made of the number of men, teams, and implements, the work each does, and the relative time of beginning the work on the part of each member of the crew. Harvesting and stacking hay and harvesting, stacking, and thrashing wheat are all examples of crew work which should receive attention. District leaders and supervisors of groups of counties will have opportunity to make studies of this kind.

The relation of methods of marketing to profit in farming is a subject of special study in the Section of Farm Economics, but those engaged in farm-management field studies and in demonstration work are instructed to give the subject such attention as conditions permit. This matter is further discussed in connection with the details of the extension work.

There is probably no more profitable work in which representatives of this office are engaged than the improvement of old, well-established systems of farming. It is seldom that any system of farming is so well perfected on even a single farm that a few simple changes will not greatly increase the net profits. It may be a slight change in the rotation, the elimination of boarder cows, the use of lime to correct soil acidity, or some other slight change that can easily be suggested by one who has visited hundreds of successful farms which will change failure to success, not only on one farm but sometimes over large areas.

In the dairy districts of the Central West a large part of the gross income on many farms goes toward the purchase of brewers' grains, bran, and other concentrates. The successful production of alfalfa cuts out this great expense. Alfalfa, however, is often a failure without lime and inoculation, and is much improved by the addition of organic matter to the soil and by comparatively deep plowing. These farmers realize the need and the value of alfalfa, but few of them know how to grow it successfully. As soon as they learn how to get large yields of alfalfa their entire system of farming will become highly profitable at once. As simple a thing as soil inoculation has often greatly increased the yields of alfalfa and made dairying highly successful over large areas.

On sandy lands in the North the introduction of hairy vetch as a green-manure crop and as a seed crop has greatly increased the fertility of the soil and has added much to the net income from farms in these districts. The growing of mammoth, or zigzag, clover for seed on such soil was found to be profitable on a few of these farms and through the influence of our field men it is now grown profitably over large areas of the sandy districts.

Skillful and well-informed farmers who have not yet attained the financial success that will warrant heavy investment in pure-bred live stock and yet who are desirous of producing such stock have been

placed in a position to get the required capital without the necessity of borrowing. This has been brought about by some of the field men by a very simple combination of the skill of the farmer and the money of the capitalist, and in every case in which this has been done the results have been satisfactory to both parties to the contract. The money is usually furnished by some one who is much interested in live stock, but who is so tied up with other business that he can not give enough attention to farming to look after the details of the work. As an illustration of how this works out in actual practice, an instance may be cited in the State of Wisconsin in which a few pure-bred Holstein cattle were purchased by one man and placed on the farm of another. The contract, which is to run for five years, requires that the farmer furnish all the feed, in return for which he is allowed all the milk. The farmer also receives one-half the proceeds from the sale of male calves, and no heifer calves are to be sold except by mutual consent until the maturity of the contract. At the time of settlement the original investment is returned to the investor. Of the increase the farmer receives one-third and the man who purchased the cattle receives two-thirds. This particular investment has proved highly profitable to all concerned.

This is a much more legitimate use of capital than the buying up of large tracts of arable land and holding them for a rise in value: in fact, the purchase of land for this purpose is not for the best interests of the country, while the investment of capital in all kinds of productive agriculture is to be commended.

A fertile 500-acre farm in central Michigan had been so badly managed that for 10 years it had not paid any interest on the investment and had scarcely furnished enough income to cover the running expenses. At the request of the owners, representatives of the Office of Farm Management visited this farm and studied the details of its management. On their recommendation, 4-horse machinery was substituted for 2-horse machinery, the poorest of the cows were sold and the money invested in good cows, a silo was built, and many other minor changes were made. It was also recommended that in addition to his salary the foreman be allowed 10 per cent of the net income after the expenses, not including interest, were paid. The owners objected to this at first, until they understood that for every dollar the foreman received in this way the owners would receive $9. They were then anxious to make this agreement. The first year after these changes went into effect the farm paid all expenses and 5 per cent interest on the investment of $60,000.

Not infrequently dairy farmers are found who are making no profit because their cows are not capable of producing enough. By inducing them to keep records of the product of each cow and then

to dispose of those that fall below the standard unprofitable farms may frequently be made profitable.

In many sections of the country the systems of farming do not provide a sufficient supply of humus in the soil. For instance, in many localities in the Ozark region the leading crops are corn and wheat, and very little else is grown on many farms. It has been found that a rotation of corn, corn, cowpeas, wheat, wheat is well adapted to that region, and by sowing cowpeas in the first-year corn, wheat in the second-year corn for winter pasture, and cowpeas as a catch crop after the second-year wheat an excellent cropping system is obtained that not only keeps the soil well supplied with humus and distributes the work so as to employ the same number of teams at all times during the season for field work, but furnishes roughage that renders the system well adapted to almost any kind of live-stock farming. While this system is a marked improvement over those prevailing quite generally in this region, it introduces only one crop that is new to the farmers, and thus does not appear to them as a radical change from their present methods. It also builds up the soil rapidly. Many other illustrations might be given showing that apparently simple changes in the systems of farming found on many farms and frequently over entire regions will often suffice to convert poor systems into good ones.

The work thus far outlined for this section of the office relates to what may be called farm-management problems proper. There are many agronomic problems which are best studied in their relation to farm practice. This is especially true of those problems that are so broad that ordinary experimental methods will not solve them. Perhaps the most important general problem of this character is the relation of farm practice to crop yield, already mentioned in discussing special farm-management problems.

This is a problem in applied agronomy. Every farm that has a system of soil management which has been in vogue long enough to show its effect on crop yields has a lesson to teach regarding the relation of various practices to soil fertility. There are many farms of this kind. The aim of this work is to secure from each of these farms a record of every detail that affects crop yields, such as the varieties of crops grown, the character of seed used, the depth of plowing, methods of preparing seed bed, methods of intertillage, including the kinds of implements used, methods of managing and applying manure, the kind and quantity of manure used, and complete statements of the methods relating to the use of fertilizers, lime, etc. A record should also be made of the character of the soil and of the crop yields obtained. Large numbers of such records of farms distributed over wide areas will, it is believed, permit of such statistical

treatment as will reveal the influence on crop yield of each of the factors mentioned. Comparatively little progress has been made on this problem by the experimental method, when it is remembered that it has probably received more attention than any other agronomic problem. The main reasons for this are our lack of knowledge of conditions existing within the soil, the great variability of the experimental results, and the limited application of results obtained in a given locality. The two latter difficulties can be overcome only by securing large masses of data from all the numerous soil types, such as it is possible to secure by a far-reaching study of farm practice. This is another type of work in which, on account of the great variability of experimental results, no great additional accuracy can be obtained by a highly accurate determination of yields. In such cases quantity of data is vastly more important than accuracy of single observations.

Before the full value of the method of farm-practice investigation was realized the problem of the relation of different types of farming to crop yields had been attacked by the experimental method in cooperation with the Kentucky and the Maryland agricultural experiment stations. At each of these stations extensive series of plat experiments were instituted, in devising which an attempt was made to provide a test of certain types of farming which would represent in a general way all types. In order to secure definite results it will be necessary to continue these experiments during a long series of years. In time they will form a useful check on the results obtained in the study of farm practice, even if the results are applicable only to the soil types on which the experiments are conducted.

Some features of the relation of farm practice to crop yield may very well be studied independently. One of these is the management of manure. Much study has been given to the chemical composition of manures and to the effect of different methods of handling manure on the loss of chemical ingredients. Yet farm methods are little better now than they were two or three generations ago. This is partly because the problem of manure management is a difficult one in practice, and farmers have been left to their own resources in solving it. The task has been too great for the average farmer. The object of the present study is to help the farmer in the solution of the problem of securing the benefits of the manures with the least expenditure of time, effort, and money. It involves a study of the equipment for saving manure and protecting it from the weather; the cost, adaptability, and care of this equipment; the point in the rotation at which manure is applied and the quantities used; the equipment for distributing manure, the cost and practicability of this equipment, the power required to

operate it, and the labor cost of distributing manure by means of it; the quantity of available manure produced per head of stock of different kinds under different systems of stock management; the relative value of manure from different kinds of animals and of the same kind under different systems of feeding; the kinds of crops to which manure from different animals is best adapted; the methods of composting; the conditions which justify the expense of composting; the cost of manure when it is obtained from outside sources; the value of manure as measured in increased yields under different conditions, etc.

A related problem which may be studied independently and on which a bulletin has already been issued by this office is farm practice in the use of commercial fertilizers. (See Farmers' Bulletin 398, entitled "Farm Practice in the Use of Commercial Fertilizers in the South Atlantic States.") It involves a study on individual farms of the kinds of fertilizers used, with reference both to the fertilizing substances and to the percentage of fertilizer elements contained; sources from which the fertilizer is obtained; methods of mixing; proportion of various ingredients required to give mixtures of any desired composition; use of ready-mixed compared with home-mixed fertilizers; equipment required for storing, mixing, and distributing; cost and practicability of such equipment; cost, including labor and time required for mixing and for distributing; rate of application; crops to which applied; time of application; manner of application, whether broadcast on surface, in rows with the seed, in rows and mixed, or covered with soil before planting the seed; means used in keeping up the humus supply so as to make fertilizers more effective; relation to yields; cost of fertilizer; accumulative effects on soil and how to overcome injurious effects, etc.

Local agents in regions where commercial fertilizers are largely used, especially where they are used in large quantities, should ascertain what saving can be made by the farmers in buying fertilizer ingredients separately and mixing them themselves. If the saving is found to justify encouraging this practice it is well to give demonstrations in the home mixing of fertilizers.

Farm practice in the use of agricultural lime may also be studied as an independent problem. District leaders, State leaders, supervisors, and local agents should cooperate in ascertaining the sources from which agricultural lime may be obtained and the prices at which the lime can be delivered at local stations. Both local agents and supervisors should give careful study to the needs of the various soil types in their territory concerning lime and to the best practice in the use of this soil amendment. Important service can be rendered to farmers by helping them to secure a good quality of lime at the least possible expense.

Another special problem, which is a part of the general problem of the relation of farm practice to crop yields, is the use of green manures as a means of putting humus into the soil. A study should be made of the crops adapted to this purpose and the places they may best occupy in the cropping system, as well as the effect produced by the use of such crops.

WORK OF THE LOCAL AGENTS.

It is impossible to outline in detail the problems the extension worker will meet with in any given locality in advance of the actual investigation in the locality, because these problems are so numerous and vary so greatly with local conditions. The extension worker himself must investigate local conditions and determine the particular needs of the community in which he works. The suggestions which follow, therefore, are not presented with the idea that they cover the ground fully in any given case, or with the expectation that local agents will undertake any large number of the problems to which attention is called. The best results will usually be obtained by concentrating very largely on one or two, or at least a few, lines of extension work, giving only incidental attention to others. From year to year the lines on which effort is concentrated will change according to the exigencies of the case.

Before undertaking extension work in any locality it is an excellent plan for the extension worker to tabulate all available census data concerning the agriculture of the region. He should also construct a rainfall map from the available data of the United States Weather Bureau and in all western sections should familiarize himself with the seasonal distribution of the rainfall, as this is important nearly everywhere in the West. He should determine the length of the growing season and should become familiar with the geology of the region, and if the Geological Survey has made a topographic map he should secure a copy. If the Bureau of Soils has made soil surveys, copies of the soil maps should be obtained and studied with care. Study of this kind makes a man familiar with the region in a general way even before he visits it and puts him in a position to assimilate data gathered by the study of farm practice much more readily than if he did not have this general knowledge of the locality.

The extension worker should also familiarize himself with the organization of the cooperating State institution and of the United States Department of Agriculture in order that he may know the sources of information in these institutions and become familiar with the work of experts who can render service to farmers in his territory. He should especially become familiar with the literature of these institutions relating to the region in which he works.

In beginning extension work in any locality one of the first things to do is to hunt up all the successful farmers who can be found and to make a careful study of their work. This should include a study of the types of farming followed, the cropping systems used, methods of keeping up soil fertility, and the details of the management of each enterprise on the farm. For suggestions as to the manner of making such study, see what is said under the heading "Study of successful farms," on page 37 of this bulletin.

A striking advantage which arises from this study of successful farms is the fact that the field man soon acquires a vast amount of local knowledge which makes him a welcome visitor on any farm, for farmers are always eager to learn the methods of those whom they regard as successful. They will listen eagerly to a description of an actual farm or any of its methods, while they will look askance at any suggestion that has not been tried out in practice. Farmers' Bulletins describing in detail the system of management on a single farm are read eagerly, and bulletins of this kind have had a larger circulation than any other type of bulletin prepared in the Office of Farm Management. Farmers practically never undertake to follow in detail the systems outlined in these bulletins, but they do adopt certain practices from them that are adapted to their conditions. (See Farmers' Bulletins as follows: 242, An Example of Model Farming; 272, A Successful Hog and Seed-Corn Farm; 280, A Profitable Tenant Dairy Farm; 310, A Successful Alabama Diversification Farm; 312, A Successful Southern Hay Farm; 326, Building up a Run-Down Cotton Plantation; 355, A Successful Poultry and Dairy Farm; 364, A Profitable Cotton Farm; 432, How a City Family Managed a Farm; 437, A System of Tenant Farming and Its Results; 454, A Successful New York Farm. See also Bulletin 102, Part II, Bureau of Plant Industry, entitled "A Successful Dairy Farm.")

In studying the details of the management of individual farms it is well to give attention to the relation of the farmer to his hired labor. This involves a study of housing and boarding; laborers' privileges, such as the use of a horse and buggy on Sundays and holidays, the use of a garden, the keeping of cows, pigs, and chickens, and access to farm papers and other available literature; the personal relations of the farmer and his hired labor; permanency of employment; and the relation of all these factors to the difficulty of securing farm laborers and the efficiency of this labor.

In studying the agriculture of a community attention should be given not only to defects in methods, but to defects of organization. The extension worker should read carefully the discussion of farm organization and equipment in the first part of this bulletin. (See pp. 9–30.)

Not only is it possible for the extension worker to help the farmer in the matter of the selection of enterprises that are to constitute the basis of his business and in the details of the conduct of each of these enterprises, but he can render occasional assistance by giving advice on such subjects as the cost of farm dwellings and plans and cost of other farm buildings. (See the discussion of the "Cost of farm dwellings," pp. 29–30 of this bulletin; also Farmers' Bulletin 438, entitled "Hog Houses.") He can be of special help by giving advice concerning equipment in farm machinery and in the care of this equipment. The extension worker should also familiarize himself with the number of work horses required on farms of a given size and type, as well as the number of laborers at different seasons of the year. This information can be obtained in connection with the study of the work on successful farms.

The maintenance of crop yield should always be a major consideration. The man engaged in extension work should master this subject locally as well as generally, and wherever yields are less than they should be an effort should be made to correct this defect.

It is important that farmers should use good seeds. So far as practicable farmers should be encouraged to grow their own seeds and should be taught how to select and care for seeds for the next year's planting. Where it is not practicable for farmers to do this, it is well to encourage a few men in each locality to produce a high quality of seeds to be sold locally. But this should not be overdone, as there might not always be a market for the seeds. Where it is not practicable to have seeds grown locally, service should be rendered to the farmer by helping to secure good seeds from other localities.

It must not be forgotten that of the 6,000,000 farmers in this country many of them possess great ingenuity and originality, and in practical affairs these men frequently work out the solution of problems that are of general interest. Extended study of farm practice in any region will reveal many interesting things of this character.

The Office of Farm Management has issued a number of important bulletins relating to methods of exterminating some of the worst weeds of the country. (See Farmers' Bulletins: 279, A Method of Eradicating Johnson Grass; 368, The Eradication of Bindweed or Wild Morning-Glory; 464, The Eradication of Quack-Grass; and Circular (Document 416), Bureau of Plant Industry, entitled "The Wild Onion.") Local agents should familiarize themselves with such of these bulletins as are of local interest. Where there is a serious weed pest the methods for the control of which are known, the farmer should be taught this method. Where noxious weeds are found for which no method of control is known, the State experiment station

and the Office of Farm Management should be notified. It is, in fact, an important part of the work of the local extension man to put farmers in touch with the work of the various experts of the Department of Agriculture and the cooperating State institution.

Particular attention should be given to the methods of preparing land for seeding, including the season of the year at which plowing is done, the depth of plowing, the methods of fining the seed bed, etc. The methods and the implements used in tilling intertilled crops should be studied carefully. Usually the practice of the most successful farmers should be the guide in local practice unless it is known that there are better methods. The possibility of using plows, harrows, and tillage implements of large size should receive attention. On farms that are large enough to justify the practice, and in regions where conditions permit, it is economy to use the largest practicable sizes of all field implements.

In the matter of insect pests and fungous diseases local agents are not expected to become experts. Generally speaking, the best they can do is to call to the attention of experts in the State experiment station and in the Department of Agriculture problems of this character when they arise locally. In many cases either the State experiment station or the proper office in the Department of Agriculture will be able to furnish directions which the local agent can apply or even which the farmers can apply under the direction of the local agent. This ought to be possible in the treatment of grain for smut and in the spraying of orchards. Frequently, also, the method of controlling insect pests can be handled in a similar manner.

In regions where there are orchards improperly cared for, the local agent should familiarize himself with orchard practice and give demonstrations in pruning and spraying, and also in picking, sorting, and packing fruit for the market. Some of the local agents have been very successful in this work and have greatly increased the income of farmers from the sale of fruit from orchards which before had brought the farmer little or nothing.

In any locality where some special crop, such as potatoes, tomatoes, apples, etc., is important, the local agent and the supervisors should make themselves familiar with the management of these enterprises in order to be able to teach farmers the most improved methods. (See Farmers' Bulletins 323, entitled "Clover Farming on the Sandy Jack-Pine Lands of the North"; 365, "Farm Management in Northern Potato-Growing Sections"; 491, "The Profitable Management of the Small Apple Orchard on the General Farm. See also Bulletin 124, Bureau of Plant Industry, "The Prickly Pear as a Farm Crop"; Circular 28, Bureau of Plant Industry, "Clover-Seed Production in the Willamette Valley, Oregon"; and Farmers' Bulletins

relating to particular crops; also similar State experiment station bulletins.)

The marketing of the products of these special crops is usually one of the most serious problems that confront the farmer, and all assistance possible should be given in this matter. Particular attention should be paid to the size and the style of package which the market demands. Farmers should be made to understand that attractiveness is worth even more than intrinsic quality in the sale of farm products, especially those that are exposed for sale in retail stores in the form in which they leave the farm.

Many farmers will be found who are making the attempt to keep some kind of record of their financial transactions and the work on their farms. Such farmers should be put in touch with the work of the Section of Farm Economics of this office, where much attention has been paid this subject; also with such cooperating State institutions as are doing work along this line.

In most localities it will be found desirable to hold meetings at country schoolhouses or elsewhere for the discussion of timely subjects. At the proper season these meetings may be devoted to the discussion of such subjects as lime, its source, cost, where and when to apply; fertilizers, kinds to buy, quantities to use, how and to what crops to apply, prices, how to mix, etc.; potato culture; renovation of orchards; the farmer's garden, etc.

In reaching the farmers, free use should be made of local papers. Copies of all articles prepared for publication in this manner should be sent to the Office of Farm Management. It is an excellent plan to secure a list of the names and addresses of all the farmers in the territory of the local agent, with brief data concerning their farming. The possession of these names permits the preparation and distribution of timely circulars, which should in all cases be previously approved by those in general charge of the extension work, including the section leader in this office.

Local agents can be of much assistance to farmers by helping them to organize associations for such purposes as the cooperative marketing of fruits and truck crops, the purchasing of fertilizers and seeds, etc. It is not wise for local agents to accept official positions in such organizations, since they should be managed by the farmers themselves. The idea is to teach the farmers to help themselves. In many sections of the country local agents have organized farm-management clubs and guided them in the consideration of real farm-management problems.

All those who are engaged in agricultural extension work should keep in close touch with the rural schools and should attempt to interest both teachers and pupils in the boys' and girls' agricultural club work. Much service can also be rendered in the introduction of

agriculture into the rural schools by giving advice to teachers concerning the nature of the work that can be done, and especially by putting them in touch with sources of information in the State colleges and in the Department of Agriculture.

BOYS' AND GIRLS' AGRICULTURAL CLUB WORK.

The Office of Farm Management employs a specialist whose business it is to assist State and local authorities in the organization and conduct of boys' and girls' agricultural clubs. The boys' corn clubs and the girls' canning clubs have been very successful wherever work of this kind has been undertaken and have aroused a great deal of enthusiasm for improved methods of farming and farm-household administration. Full information regarding the details of this work and the service the office is prepared to render in connection with it will be sent to any applicant. This work in the cotton States is conducted by the Farmers' Cooperative Demonstration Work; in other States by the Office of Farm Management.

UTILIZATION OF CACTI AND DRY-LAND PLANTS.

When the Office of Farm Management was organized and the work with grasses and forage plants transferred elsewhere the work with the cacti and dry-land plants was retained because of the personal interest of representatives of this office in certain important problems relating to these, and it has since been maintained in the Office of Farm Management at the request of those in charge of the work in order that they might be free from administrative details and thus be able to devote their entire time to the investigation.

The first investigations of the cactus as an economic plant represented a study of farm and range practice in the use of these plants as forage for cattle. This study revealed so much of interest that the data obtained in it were published and formal investigations instituted with a view of determining just what value the cactus might possess both as forage in its wild state and as a farm crop. A large collection of varieties and species was made, especially in our Southwestern States and in Mexico, but also from other parts of the world. These have now been grown for several years with a view of ascertaining their possibilities as cultivated crops. Plantations are maintained at San Antonio, Tex., Chico, Cal., and Brownsville, Tex.

The numerous spineless forms that have been investigated have proved to be very sensitive to cold and can be safely grown only in localities where the temperature does not fall below 20° F., and seldom reaches this minimum. These spineless forms make good chicken feed, are excellent succulence for the dairy, and are relished

by hogs. Some use is also being made of the plants as a succulent feed for Belgian and other hares. This group of plants can be made a paying crop where the conditions of temperature and moisture are suitable.

Much time has been spent in working out the cultural details of the cactus when grown as a farm crop, such as the distance between the rows and between plants in the row, methods of planting, the methods and amount of cultivation required, the age at which the forage may be harvested, and the methods of harvesting. One great advantage of the spiny cactus is that all that is necessary in feeding it is to burn off the spines from plants standing in the field. Stock may then be given free access to the field, where they will confine their attention entirely to plants that have been thus artificially prepared for them. This makes the harvesting of the crop, as well as the feeding of the stock, a very simple and inexpensive matter.

Several feeding experiments have been conducted to determine the forage value of the cacti. At the present time such an experiment is being conducted in cooperation with the Bureau of Animal Industry of this Department. These investigations include the conduct of digestion experiments. An effort is being made to determine the proper place of cacti in the rations of live stock of different kinds and to determine the effects of continuous feeding of cactus forage for long-continued periods. The following publications relating to cacti have been published: Bulletins of the Bureau of Plant Industry, No. 74, The Prickly Pear and Other Cacti as Food for Stock; 116, The Tuna as Food for Man; 124, The Prickly Pear as a Farm Crop; and 140, The Spineless Prickly Pears; Farmers' Bulletin 483, The Thornless Prickly Pears; and Bulletin 91 of the Bureau of Animal Industry, Feeding Prickly Pear to Stock in Texas.

The range investigations being carried on by this office are designed to secure accurate data upon the following subjects:

(1) Assurance as to the possible recovery of run-down ranges of different types under partial and complete rest, and the rates at which recovery occurs.

(2) The possibility of improving the native ranges artificially.

(3) The carrying capacity of the ranges, present, normal, and possible.

(4) An estimate of the area and geographic distribution of the open range, with a summation of published topographic and climatic data relating thereto.

(5) The chemical composition of and the botanical and economic data concerning the different species of range forage plants.

(6) Range management with different kinds of stock with and without fence.

Several years ago an area of over 50 square miles of badly overstocked and depleted open range land in southern Arizona was set aside as an experimental range and placed under the control of this office. The land was fenced and the greater part of it has been allowed to recover naturally. The remainder was divided into several

pastures and has been carrying stock, mostly cattle, all the time. Data as to the exact number of head upon known areas have been obtained for something over three years. The areas in question have been under the management of different men, each using his own judgment as to the best method of treatment, modified only in so far as necessary to secure accurate data.

Data as to the production of both spring and summer feed at various places on the large unstocked field have been collected for a number of years. For the past three years the grass crop on several areas 25 to 40 acres in extent within this large field has been cut and the quantity of hay per acre determined.

Thus far this experimental range has demonstrated that a range in southern Arizona will recover approximately its normal carrying capacity in three to five years if allowed complete rest. This fact was seriously doubted by experienced stockmen of the region before this series of experiments was commenced. It has also shown that with proper control this range will slowly improve while carrying stock almost up to the limit of its carrying capacity. Data upon this point show a slight general increase in carrying capacity of the areas under stock.

The hay-cutting operations and the collecting and weighing of the spring feed are beginning to furnish accurate data on the actual amount of feed per acre produced annually on the protected range. These data and those obtained from the records of stock actually carried on adjoining measured areas will give something definite as to the normal carrying capacity of this region.

Numerous attempts have been made upon this large area and on another area of about 2,500 acres to increase artificially the quantity of forage produced by seeding, tillage, and conservation of the rainfall and run-off. Many different kinds of forage-plant seeds have been sown and cacti of several different species have been planted in an attempt to secure increased productivity on the areas referred to, but only a nominal increase in the forage crop has been secured. The sowings of some of the native grass seed have given positive results in a few cases, but mostly such attempts have been fruitless.

Extensive attempts to retain the surface run-off by systems of low dams have given some improvements in the forage crop, but the expense was out of all due proportion to the results achieved. Results from tillage experiments have been negative in character.

On all field trips of the parties in charge of these investigations data are being collected as to the area of open range land in the arid region and its geographic distribution, in order to be able to map it roughly. Published meteorologic and topographic data which affect the natural distribution of the native forage plants are being

compiled from time to time as opportunity offers. Field notes of the distribution and density of forage plants, especially of grasses, are taken at all times.

For several years specimens of all kinds of forage plants have been collected on field trips for chemical analysis. The procedure has been to collect a sufficient quantity for the chemist and to make one or more botanical specimens of the same material, with occasional photographs showing the habit and habitat of the species. Copious field notes are taken on the economic importance of the species. The material for analysis is sent to the Bureau of Chemistry for a quantitative analysis, this work being carried on in collaboration with that bureau. A large number of such analyses have already been completed and the botanical notes relating thereto collected in a form ready for publication. More than 100 species of important grasses and grasslike plants are listed. It is expected that this investigation will result in a reference work for the chemical and botanical data available on all species of wild forage plants.

The remaining work on the utilization of dry-land plants relates largely to range management, and as this is mainly a study of range practice, this particular line of work is closely related to the general work of the Office of Farm Management. The work in range management relates to the various methods of management of stock, particularly cattle and sheep, upon the native ranges of the arid region, and considers the methods in common use on fenced and unfenced areas and the relation of the business to the forage conditions of the different sections. Data as to the cost of various operations, the construction and care of machinery and equipment, methods of handling stock, causes of loss of stock, and methods of disposing of the output are collected and summarized. The data are obtained from experienced stockmen in different parts of the country working under different range, climatic, and commercial conditions.

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